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# WORLD PETROLEUM


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## CONTENTS


**War Demand for Roumanian Oil . . 25**

**Fuel Oil Demand Creates Unbalance . 28**

**Cole Committee Concludes Hearings . 32**

**Effect of British Rationing . . . 33**

**Review of Mississippi Discovery . . 38**

**N. Y. Nomads Organize . . . . 56**

**Tide Water Promotions . . . . 58**

**World Crude Production Tables . . 62**

**Abstracts of World's Oil Literature . 64**



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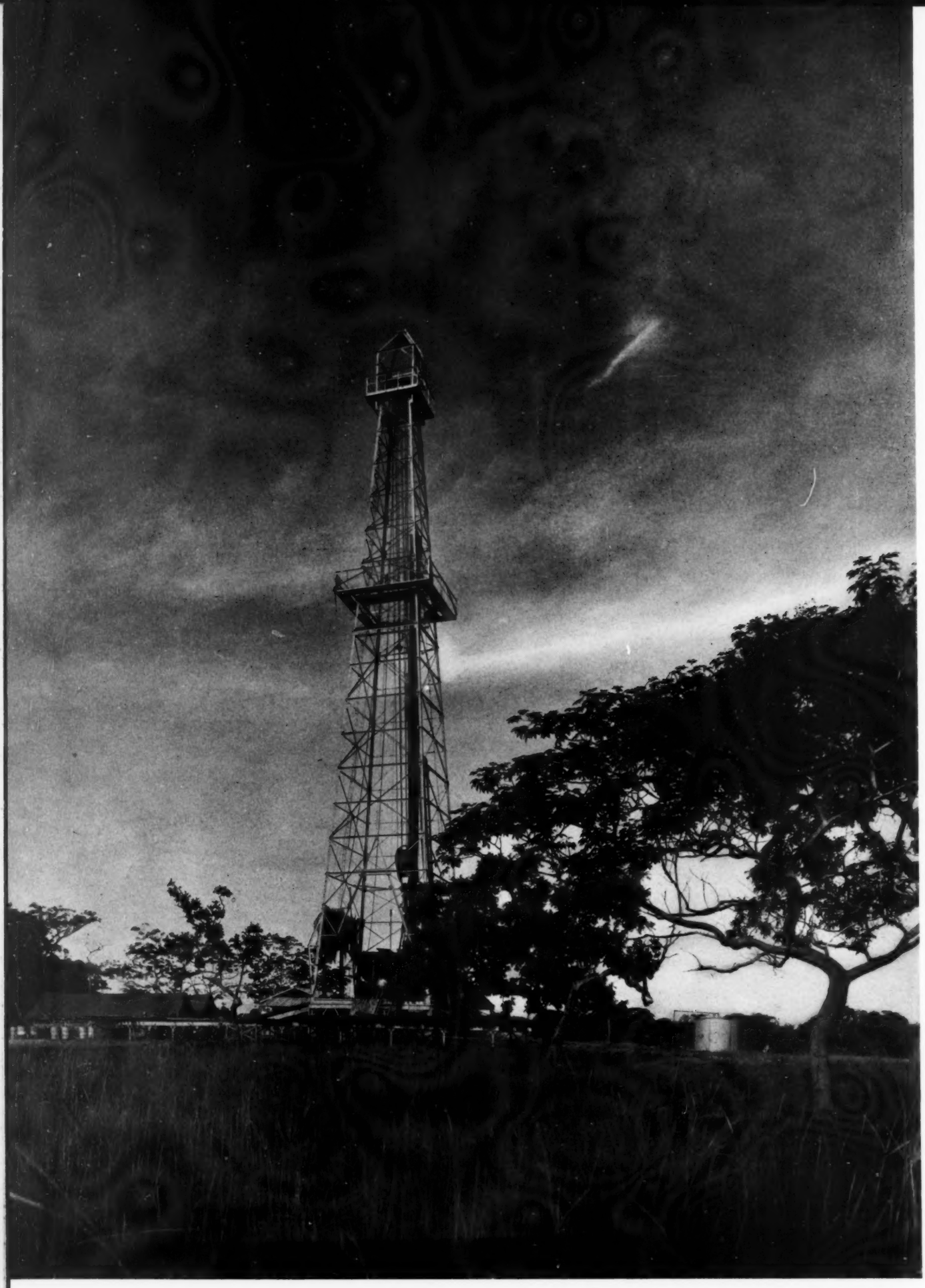


*Socony-Vacuum's Carrizal No. 1, Wildcat in Eastern Venezuela: The front cover illustration shows Shell's pipeline from the Colon region to Lake Maracaibo, also in Venezuela. both photographs were taken by Robert Yarnall Richie especially for* WORLD PETROLEUM.

# EDITORIAL

## BALANCING FUEL OIL AND GASOLINE SUPPLIES

GASOLINE stocks in the United States, which are discussed as a grave danger to market stability wherever oil men gather, have now surpassed all previous records and are verging close to the 100,000,000 bbl. mark. Unbalance between the production of gasoline and light fuel oil and the supply-demand ratio of these products is recognized as the cause of this unsound development but the question of how to correct it is one that is not easy to answer.

In February there was included in these pages some discussion of factors affecting this situation which grows more acute from season to season. This month WORLD PETROLEUM is fortunate in being able to present a careful study of the subject by a man of national reputation in the industry who, from the vantage ground of his association with one of the great marketing organizations of the country, has been able to assemble statistical and other information which presents a very clear picture of the causes of the present uneven distribution of supplies at different periods of the year.

The remedy suggested by this authority is a very simple one. It involves no greater change in refinery practice than the maintenance during the second and third quarters of the year of the same relationship between gasoline and fuel oil production that now prevails during the fourth quarter. His proposal in effect is that fuel oil supplies be built up during the summer months just as gasoline stocks are accumulated in the winter and he points out that this can be accomplished without changing operation to an extent that would cause any serious inconvenience to refiners while it would avoid the building up of stocks of either product to heights that could be regarded as dangerous.

It needs only a glance over the statistics of the past few years to demonstrate that the demand for light fuel oil has been growing at a consistently higher rate than the demand for gasoline. For the five years 1935-1939 inclusive the rise in fuel oil consumption averaged 13.3 percent per year while in gasoline the yearly increase was 7.01 percent. There is nothing to indicate that this trend will be changed materially in the near future. Once a real start is made toward general business recovery, with the increased building of homes and industrial plants that naturally will attend it, the divergence may become even more marked than it is at present.

At any rate it must be recognized that the status of light fuel oil is rapidly changing, that it cannot be regarded as in the past merely as a by-product, but that it is gradually attaining a position alongside gasoline as a major product and must be treated accordingly.

In the comment on this subject published last month it was suggested that the new status of heating oil as a primary rather than a secondary product, speaking from the marketing rather than the technical viewpoint, might call for a revision of the pricing system and some advance in the present price level of fuel oils. It is possible that this may be obviated by changes in refining technique by which the potential light fuel oil yield per barrel of crude can be increased at the expense of the lower priced residual oils and without sacrificing gasoline recovery. Whatever developments may take place in this direction it is obvious that refiners in the eastern and mid-continent areas in future must take more fully into account the growing demand for fuel oil and more particularly the lighter grades of such oil employed increasingly for residential heating and special industrial purposes.

Special attention has been directed to this question by weather conditions during the past winter which brought severe and protracted cold to nearly all parts of the country. That the oil companies were able to meet the heavy demand imposed by this condition in the Atlantic Coast and central states despite the scarcity of tankers and the high transportation cost which stood as a barrier to the movement of products from the Pacific Coast and other distant points is a tribute to the adaptability of the industry and its readiness to serve the public even at loss to itself when conditions demand this.

While the importation of fuel oil from the Netherlands West Indies was a factor in averting a threatened shortage on the Atlantic Seaboard during the past two months this cannot be regarded as a dependable source of regular supply. The heavy base crudes from western Venezuela give larger yields of the residuals but less of the lighter fuel oils than do domestic crudes from the Eastern and Mid-continent fields. The same applies to California. There is in fact a well defined export movement of distillate fuel oils from the United States to the Netherlands West Indies. Until the commencement of the war the demand from other export markets for these products was rising steadily and this movement undoubtedly will be resumed whenever hostilities cease. Whatever adjustment is to be made, therefore, must come through a revision in the supply-demand relationship of gasoline and light fuel oils. To obtain acceptance within the industry such a change must be based on sound technical operation, a phase of the subject that will be discussed more fully next month.

▼

**RACE OF THE OCTANES**

TYPICAL of the oil industry is a movement which has been going on in the United States during the past several months. There probably is no other industry in which quite the same development could have taken place. It illustrates at once the abnormally keen spirit of competition that exists among the purveyors of petroleum products and the lengths to which they will go in disregard of reasonable profit in efforts to woo and win the motoring public. As a suitable description of this phenomenon we may call it the race of the octanes.

Oil company advertising over the past two or three years has made the public octane conscious. The average motorist who speaks glibly of different octane numbers may not have the faintest understanding of their real significance but the impression has been drummed into his mind that the higher the octane number the better the gasoline which may or may not be the actual case depending in part upon the make and model of his car.

Successive improvements in refining have made it possible to produce motor fuel of increasing high octane rating and as these fuels have become available in greater quantities they have been placed upon the market, usually at no advance in price. Thus it has come about that the standard grade of gasoline sold in most parts of the country today is markedly superior to the "super" grades of three to five years ago.

This movement toward raising the octane standard of motor fuel has taken on accelerated force within the past year due to somewhat radical improvements in refining practice. As one company after another has placed itself in position to produce these higher test gasolines they have not failed to tell the public of the fact through all available channels of publicity. Other companies, feeling that they cannot afford to let their customers gain the impression that their product is not the equal in every respect of that offered by their competitors, have swung into line and have taken the steps necessary to raise the octane rating of their motor fuel.

As a result of this race for first line position in the matter of octane rating it is estimated by men thoroughly familiar with the refining and marketing branches of the petroleum trade that the industry will spend $25,000,000 in the year 1940 in order to raise the octane of its regular gasoline by three to five points. The results of this added investment and expenditure are being passed along to consumers with virtually no added charge. The cost must come out of a margin between crude and gasoline prices that already was inadequate to yield a reasonable profit.

It is in line with oil industry precedent too that this race of the octanes has become something of a craze and threatens to create a distorted notion of fuel values in the minds of the non-technical public. High octane gasoline has anti-knock qualities that make it valuable for use in high compression engines, but octane rating is not to be regarded as the sole test of a motor fuel. Other characteristics enter into the production of a well balanced gasoline for the average motor car on the road today and these should not be overlooked in the publicity efforts of the oil companies' advertising departments lest a mistaken popular impression be created.

This consideration, however, does not affect the point above referred to, that in the exuberance of its competitive spirit the oil industry is spending millions of dollars this year in producing higher test gasoline and is making a gift of these millions to the motor using public, a philanthropic gesture that many of its members can ill afford.

▼

# WARRING NATIONS

## Compete for Diminishing Roumanian Oil Output

FOR some months the situation of the Roumanian oil industry has provided food for speculation as to the part this industry will play in the war between the British-French alliance and the German Reich. As most readers of the newspapers are doubtless aware the matter has chiefly related to whether Roumanian oil should or should not flow to the Reich in greater volume to supply the German military machine. In order to increase the flow to them the Germans have been putting pressure on the Roumanian government, even to the point of threatening military action. On the other hand the British-French alliance has guaranteed military assistance in case of a German attack and on the basis of this engagement have themselves been putting pressure of their own on the Roumanians to restrict or at least not to increase their deliveries to the Germans.

The limits of the situation may be best considered in the light of the current physical and technical status of the Roumanian oil industry. The country possesses sixteen named oil-producing districts. An official census as of November 30, 1939, showed a total of 142 flowing wells, 2,231 wells on pump, 45 wells drilling and 40 wells undergoing repairs.

The history of the industry during the past five years apparently indicates that the underground oil reserves are on the way to exhaustion. This conclusion is suggested by the figures of crude oil production in Table I.

**TABLE I**

**Annual Crude Oil Production**

| Year | Production Metric tons |
|---|---|
| 1933 | 7,387,000 |
| 1934 | 8,467,455 |
| 1935 | 8,394,000 |
| 1936 | 8,704,000 |
| 1937 | 7,147,000 |
| 1938 | 6,620,000 |
| 1939 | 6,250,000 |

From an all-time peak of 8,704,000 tons in 1936, in three years production has dropped to 6,250,000 tons, a decline of practically 30 percent. This decline is especially marked in the older fields, such as Gura-Ocnitzei, Moreni, Piscuri, Boldesti, Bucsani, Ochiuri and Rasvad, where the drop in production has been of the order of 18 to 28 percent. The only district showing an increase during 1939 was Tzintea which produced 1,100,000 tons as compared with 622,000 tons in 1938, an increase of nearly 75 percent for this district. But the jump in this one district, considerable as it is, has not been sufficient to offset the decline in the other fields.

According to some authorities the decline in Roumanian crude oil production will bear an explanation different from the theory of exhaustion of reserves. These authorities contend that there is much more oil to be had in fields yet unexploited, but that existing mining legislation makes it impossible to obtain new drilling concessions on favorable terms. The oil companies are therefore restricting their operations to definitely proven fields.

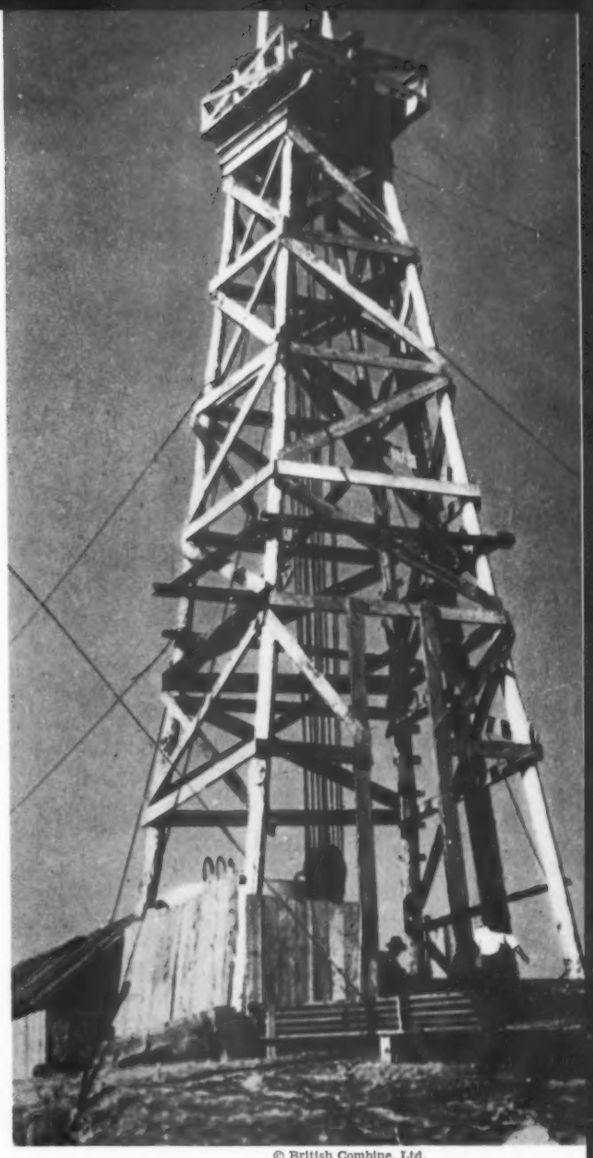
The decline in production has in fact been paralleled by a decrease in the rate of new drilling as indicated in Table II.

**TABLE II**

**New Drilling in Relation to Production**

| Year | Production tons | Footage drilled |
|---|---|---|
| 1938 | 6,620,000 | 936,000 |
| 1939 | 6,250,000 | 845,000 |

It is interesting to ask whether the war which began on the first of September, 1939,



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*Right, typical wooden Roumanian drilling rig near Campina. Below, one of the critical points in the possible route of Soviet oil flow to Germany, Przemysl, formerly in Poland, now the dividing line between Russia and Germany where oil must be transferred from Soviet wide-gauge tank cars (on left) to German narrower-gauge on right.*

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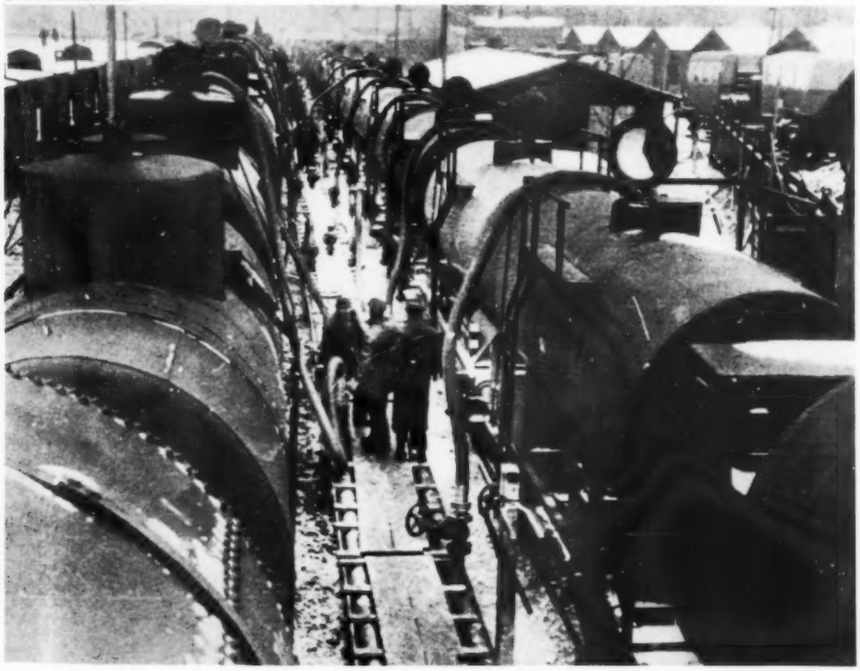

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*Primitive methods are still used in drilling and production in Roumania where every effort is made to hold down capital investment: ventilating hand dug pit by hand.*

has had any appreciable effect in stimulating Roumanian production. The first column of Table III shows the production and drilling figures for the first six months of the year, and the monthly figures from July to December. These figures refer only to operations of the 26 incorporated companies which together account for 96 percent of the total:

**TABLE III**

**Monthly Drilling and Production 1939**

| Period | Production tons | Drilling, meters |
|---|---|---|
| Jan.-June | 2,980,464 | 132,692 |
| July | 508,134 | 22,314 |
| August | 518,034 | 21,392 |
| September | 495,750 | 16,524 |
| October | 506,558 | 18,815 |
| November | 492,843 | 20,716 |
| December | 501,645 | 22,233 |

From these figures it is seen that during the first six months of the past year the total production was 2,980,464 tons, or at the monthly rate of 480,077 tons. This was bettered a little in July and August, just before the war started, but during the last four months production barely averaged 500,000 tons a month. The production figures thus far do not reflect any war stimulus.

Since drilling must precede production any stimulus due to the war demand would first be evident in the drilling figures. The total meterage drilled in the first six months was 132,692 or a monthly average of 22,115, a figure which was closely maintained in July and August. On the other hand the average for the four war months showed a perceptible decrease winding up with 22,233 meters in December which was no better than the average of July and August.

The basic facts of the situation thus are that total production of Roumanian oil is showing an annual decline, that the extraordinary demand (evidenced by the prices recently offered) has shown no signs as yet of stimulating either the drawing of a larger supply from existing wells or new drilling to obtain additional producers, and that there is no prospect of opening new fields or new formations unless restrictions now imposed on exploration and exploitation are removed. There is therefore little or no prospect that oil production in Roumania in 1940 will much exceed 6,000,000 tons, if it should even reach that figure.

As was stated above, an increase can come only from tapping new fields and there is now another reason other than restrictive mining legislation for not expecting an extension of the industry. Exploratory drilling requires a large investment of new capital, and there is little new capital in Roumania itself (Roumanian investments in the industry amount to no more than about 10 percent of the total). The only source from which new outside capital could come is Britain, France, Belgium or Holland, or perhaps the United States, and it is very unlikely that capitalists in those European countries would be allowed by their governments to produce oil that would go to Germany. According to unconfirmed press reports the same unwillingness to help the Germans is shared by American capitalists who have investments in the industry. It is estimated that British, French and American interests control about 86 percent of the total production.

In any case, it is extremely likely that the 1940 production of Roumanian oil will not much exceed 6,000,000 tons. From this total two deductions must be made. One is the amount of oil consumed within the country, which shows a tendency to increase as indicated by the figures in Table IV.

**TABLE IV**

| Year | Internal Consumption (tons) |
|---|---|
| 1935 | 1,479,685 |
| 1936 | 1,550,000 |
| 1938 | 1,674,046 |
| 1939 | 1,750,000 |

Besides the oil consumed in the ordinary way the Roumanian government, for well known reasons, is laying by a large reserve of unknown size for the use of its army. This reserve, which must be considerable, added to the domestic requirement and subtracted from the 6,000,000 tons expected in 1940, leaves an exportable surplus that is probably less than 4,000,000 tons.

It is the disposition of these 4,000,000 tons that constitutes the bone of contention. The Germans want most if not all of it, and the British-French insist that Roumanian oil exports to Germany shall at most not exceed the pre-war rate. In 1938 the German share in Roumanian oil exports was 22.2 percent; for the whole year of 1939 it was 30.8 percent.

While, as was pointed out above, the war has had no perceptible effect as a stimulant of production and apparently is not likely to, it has had a very considerable effect on the distribution of Roumanian oil exports, as may be seen from Table V (from Moniteur Petrole Roumain.)

What is noteworthy about these figures is that during the first three war months the shares going to Germany and the Czech Protectorate were together 33.85, 27.42 and 29.62 percent, while the shares going to Britain and France together were 18.01, 16.83 and 17.40 percent. In December the percentages were brusquely altered, 42.05 percent

**TABLE V**

**Roumania Petroleum Export in the Last 4 Months of 1939**

| Country of Destination | September Tons | September Percent | October Tons | October Percent | November Tons | November Percent | December Tons | December Percent |
|---|---|---|---|---|---|---|---|---|
| Great Britain | 32,974 | 16.01 | 29,772 | 9.75 | 37,010 | 12.34 | 139,880 | 33.91 |
| Belgium | 5,156 | 2.50 | 8,043 | 2.64 | 4,972 | 1.66 | 1,067 | 0.26 |
| Holland | ..... | ..... | ..... | ..... | ..... | ..... | 1,051 | 0.25 |
| France | 4,120 | 2.00 | 21,624 | 7.08 | 15,188 | 5.06 | 33,556 | 8.14 |
| Italy | 31,492 | 15.30 | 66,055 | 21.64 | 63,262 | 21.10 | 35,105 | 8.51 |
| Switzerland | 5,544 | 2.69 | 8,383 | 2.75 | 4,794 | 1.60 | 11,179 | 2.71 |
| Germany | 46,759 | 22.71 | 61,122 | 20.02 | 59,166 | 19.73 | 50,889 | 12.34 |
| Czech Protectorate | 22,932 | 11.14 | 22,591 | 7.40 | 29,652 | 9.89 | 31,034 | 7.52 |
| Poland | 5,179 | 2.52 | ..... | ..... | ..... | ..... | ..... | ..... |
| Gibraltar | 604 | 0.29 | 3,450 | 1.13 | ..... | ..... | ..... | ..... |
| Hungary | 3,977 | 1.93 | 6,435 | 2.11 | 7,523 | 2.51 | 9,809 | 2.38 |
| Jugoslavia | 3,780 | 1.84 | 21,688 | 7.10 | 15,788 | 5.26 | 10,113 | 2.45 |
| Bulgaria | 11,299 | 5.49 | 2,508 | 0.82 | 8,263 | 2.76 | 11,133 | 2.70 |
| Greece | 6,205 | 3.01 | 4,466 | 1.46 | 7,658 | 2.55 | 9,595 | 2.33 |
| Turkey | 3,876 | 1.27 | 559 | 0.27 | 886 | 0.30 | 5,292 | 1.28 |
| Egypt | 5 | ..... | 1,325 | 0.43 | 6,073 | 2.03 | 1,745 | 0.42 |
| Tunis | 4,739 | 2.30 | ..... | ..... | 3,698 | 1.23 | 17,975 | 4.36 |
| Morocco | ..... | ..... | 5,358 | 1.83 | 3,749 | 1.25 | 6,662 | 1.62 |
| Syria | ..... | ..... | 5,358 | 1.87 | 2,376 | 0.79 | ..... | ..... |
| Palestine | ..... | ..... | 827 | 0.27 | 2,078 | 0.69 | 5,819 | 1.41 |
| Bunker, Roumanian | 11,502 | 5.59 | 17,214 | 5.64 | 13,924 | 4.64 | 17,294 | 4.12 |
| Bunker, Foreign | 9,085 | 4.41 | 14,964 | 4.90 | 13,828 | 4.61 | 13,235 | 3.29 |
| Total, tons | 205,911 | | 305,286 | | 299,888 | | 412,443 | |

going to the British-French and 19.86 percent going to Germany and the Protectorate.

This shift in destination is the external evidence of the determination of the British-French to see that as little as possible of Roumanian oil reaches the Germans. Besides applying pressure on the Roumanian government to counteract pressure applied on the hapless Roumanians by the Germans, the Allies have gone to the Roumanian oil market with ready cash and are buying up all that is offered. That much has been offered to them is shown by the increased percentage of the total exports which they obtained in December, 1939 (figures for January 1940 are not available). In this effort to deprive the Germans of vital petroleum supplies price seems to be a secondary consideration. The price of Roumanian oil f. o. b. Constanza has gone far beyond parity with Gulf Coast prices, as indicated in Table VI.

**TABLE VI**

**Comparative Prices Per Ton, Gulf and Roumania**

| | Oct. 15, 1939 | | Jan. 15, 1940 | |
|---|---|---|---|---|
| | Gulf | Constanza | Gulf | Constanza |
| Gasoline 66 O.N. | $24.16 | $31.80 | $22.32 | $44.12 |
| Kerosene | 13.60 | 21.05 | 14.82 | 32.90 |
| Gas oil | 14.79 | 20.85 | 13.43 | 31.00 |
| Fuel oil | 6.05 | 14.10 | 6.21 | 14.11 |

Constanza prices at the present writing are more than double Gulf Coast prices.

The actual situation is that the Germans are obtaining about 20 percent of the Roumanian export surplus. If this percentage holds during the present year they will draw considerably less than a million tons from this source. Whether they can obtain more depends on eventualities which cannot now be foreseen, that is, on whether German diplomatic and commercial pressure overcomes that of the British-French, or vice versa and also on whether the Germans can find means of transportation.

On the one side the British-French point to the agreement of March, 1939, under which the Reich was to obtain 30 percent of Roumanian oil exports and they insist that in no case shall this proportion be increased. On their side the Germans have a later agreement in which the deliveries of Roumanian oil to the Reich are fixed at 1,560,000 tons a year; this would give them in 1940 around 250,000 tons more than they got in 1939. From the British-French standpoint this extra 250,000 tons going to the enemy is far from negligible, and from all accounts they are fixedly determined to prevent that oil from reaching Germany.

Details of the various moves in this war of nerves are difficult to trace in the news, but it appears at the moment that the British-French have the upper hand. Roumania is said to have promised that exports shall not exceed the prewar figure and that the recently established dictatorship over the country's oil industry will be limited to assuring that the oil companies make full provision for internal requirements and for the national military forces. As a further favor to the allies the Roumanians have agreed that shipments to Germany will be of crude oil only, and shipments of aviation gasoline to the Reich have been specifically banned. Moreover, it was reported on February 26th, that the state-owned Roumanian railroads had placed in effect a 12 to 40 percent increase in rates on freight, including oil, for export to Germany. These actions, plus rumors to the effect that secret arrangements have been made with France to supply Roumania with large quantities of warplanes and munitions apparently were extremely distasteful to the Germans. What the final upshot will be is on the laps of the gods.

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*A hinderance to possible increased German oil supplies may be found in rail transportation: rail loading racks at Campinn, Roumania, whence varying quantities are shipped to Germany.*

# UNBALANCED POSITION In Demand for Light Products Growing Acute

**Reviewing the Situation Arising From Rapidly Growing Distillate Fuel Oil Market Which Leads to Increased Runs to Stills and Consequent Unwieldy Gasoline Stocks, A Member of a Large Petroleum Organization Suggests Practical Remedies.**

THE UNBALANCED condition which exists in the oil industry today as between the demand for distillate fuel oil[1] and the required supply of gasoline is having a harmful effect on both the marketing and crude oil production branches of the business and is a subject that deserves close study and consideration by those who are responsible for charting the course which the industry takes.

Gasoline and distillate fuel oil are produced from the same crude oil and although a certain amount of flexibility exists in refinery operation, permitting the increase of one at the expense of the other, the average over-all yields of these products as actually realized over the year 1939 were out of balance with the respective demands. The situation is summarized briefly in the following tabulation which shows the demands and yields of the two products in that part of the United States exclusive of the five Pacific Coast states which will be referred to hereinafter as "East of California."

**Table I**

East of California—Thousands of Barrels
Year 1939

| | Refinery Gasoline | Distillate Fuel | Ratio |
|---|---|---|---|
| Demand*..... | 481,785 | 134,513 | 3.582 to 1 |
| Yield from Crude..... | 47.20% | 12.67% | 3.725 to 1 |

* Excludes natural gasoline.

The foregoing figures show that if the output of distillate fuel oil had been equal to the demand, then for every barrel of distillate fuel produced over the year 1939, there would have been made .143 bbl. of gasoline for which there was no market. As the total demand for distillate fuel oils East of California in 1939 amounted to about 134,500,000 bbl., the aforementioned surplus would have amounted to 18,600,000 bbl. of gasoline. Actually, however, refiners dipped into their distillate fuel oil inventories for about 2,700,000 bbl. of their required supply and made only 131,600,000 bbl. of distillate fuel oil (the other 200,000 bbl. being imported) and using the ratio shown in the foregoing table, for each barrel of distillate fuel not made there were 3.725 bbl. of gasoline not made and consequently the manufacture of some 10,000,000 bbl. of gasoline was avoided. Even so, gasoline inventories East of California were increased 8,600,000 bbl. during the year.

That gasoline inventories amounting to 92,300,000 bbl. at March 31, 1938 (75,400,000 bbl. East of California) were too high was generally acknowledged throughout the industry. That the inventories of 87,100,000 bbl. (70,200,000 bbl. East of California) at March 31, 1939 were excessive by some 5,000,000 bbl. was generally accepted. That the forecasted inventories of 100,000,000 bbl. (83,000,000 bbl. East of California) at March 31, 1940 are depressingly excessive there can be no doubt. But, if as the result of a rapidly growing distillate fuel oil market, the practice of increasing runs to stills and piling up surplus gasoline stocks is quickened year by year, what is the ultimate destination? Will there be inventories of 110,000,000 bbl. on March 31, 1941[2], and 120,000,000 bbl. on March 31, 1942, or will economic as well as practical considerations enter into the picture to bring about a balance in demand as between these products?

Up to five years ago, it was the refiners' practice to maintain their throughputs at relatively high levels in the summer months and reduce them in the fourth quarter. In the last four years the fourth quarter reduction has not been nearly so pronounced and in two of the last four years the fourth quarter runs to stills were greater than in the third quarter. The change in seasonal throughput East of California from 1935 through 1939 is shown by the following table:

**Runs to Stills by Quarters Expressed as a Percentage of the Runs for the Entire Year (East of California)**

| | Average 1931 to 1935 | Average 1936 to 1939 | 1939 |
|---|---|---|---|
| 1st Quarter..... | 23.35 | 23.46 | 23.13 |
| 2nd Quarter..... | 25.45 | 24.82 | 25.00 |
| 3rd Quarter..... | 26.19 | 25.94 | 25.87 |
| 4th Quarter..... | 25.01 | 25.78 | 26.00 |
| Year..... | 100.00 | 100.00 | 100.00 |

The numerical change in these percentage figures is small, but it must be borne in mind that these percentages apply to runs to stills of over 250,000,000 bbl. in each quarter year, and that the resultant change in the output of finished products is consequently very substantial.

While it may be argued that it is desirable to level out the seasonal variations in throughput, actually this change has come about as the result of refiners waiting until the fourth quarter before accumulating the stocks necessary to supply the demand for distillate fuel oil during the winter months, and this stepping up of runs in the fourth quarter has resulted in the accumulation of the excessive gasoline inventories previously mentioned.

Aside from the economic waste attendant on surplus gasoline inventories, the failure of refiners to accumulate stocks of distillate fuel oil during the summer months and the practice of maintaining a high level of operations during the fourth quarter to supply the demand for heating oils, results in the consumption of an excessive amount of crude oil which mistakenly has been called demand. Demand for crude oil must be defined as the amount required to supply the demand for petroleum products. Actually, there is no demand for crude oil as such, except for use as fuel within the industry and for exports, and aside from these, the use of crude oil over and above such an amount as is required to meet the demand for products, must be considered as an unnecessary consumption but cannot be called demand. It follows, of course, that consumption in excess of demand is not in the interests of conservation, should be discouraged, and should never be included in an estimate of the actual demand for crude oil.

## INCREASE IN DEMAND

In seeking a solution to the problem, it probably would be well to review the recent history and the present situation in greater detail.

Something over 80 percent of all distillate fuel oils consumed East of California is used for heating as indicated in Table II. About nine percent is used as Diesel fuel and another nine percent is used in various industries where a light fuel is required, including the railroads, gas and electric power plants, metallurgical plants, etc. In California, the distribution is somewhat different. Relatively small amounts of distillate fuel oil (and relatively larger amouts of residual fuels) are used for heating; Diesel fuel, on the other hand, comprises the major portion of the total consumption. The consumption of Diesel fuel oil East of California has increased substantially in the last four years, and during that period has accounted for an ever increasing percentage of the total consumption but as stated, the latest figures show only about

[1]The term "Distillate Fuel Oil" is used herein in preference to the Bureau of Mines' term "Gas Oil and Distillate Fuel" for the reason that gas oil as a product accounts today for less than one percent of the total consumption of distillate fuels. Considerable confusion could be avoided if the term were eliminated from the industry's lexicon.

[2]A forecast using conservative increases in the demands for gasoline and distillate fuel oils indicates that even with minor improvements in the yield ratio gasoline stocks at March 31, 1941, will be approximately 110,000,000 bbl. for the United States. (93,000,000 bbl. East of California.)

nine percent of the total distillate fuel oil being so used. In the four year period covered by Table II, the consumption of heating oils East of California has shown an average increase of 13.7 percent per annum as shown in Table III. The domestic consumption of all distillate fuel oil for this same period has increased 11.3 percent per annum. Exports have shown an increase of 29.1 percent per annum and the total demand for distillate fuels as shown in Table IV including exports and making allowances for shipments received from California has increased 13.3 percent per annum. The yield of distillate fuel oil on the other hand has increased on the average only 6.6 percent per annum. This last percentage of course applies to a constantly increasing amount of crude oil required for the manufacture of gasoline, but the disparity between the increase in the consumption of distillate fuel and the increase in the yield of that product speaks for itself.

The average yearly increase of 13.3 percent in the total demand for distillate fuel oil East of California is nearly double the increase in the demand for refinery gasoline. To make such a comparison, it is necessary to make certain adjustments in the published statistics inasmuch as the gasoline marketed has blended with it a certain amount of natural gasoline. The gasoline demand figures in Table IV, therefore, have been reduced by the natural blended during the year and the miscellaneous supplies which find their way onto the market as motor fuel.

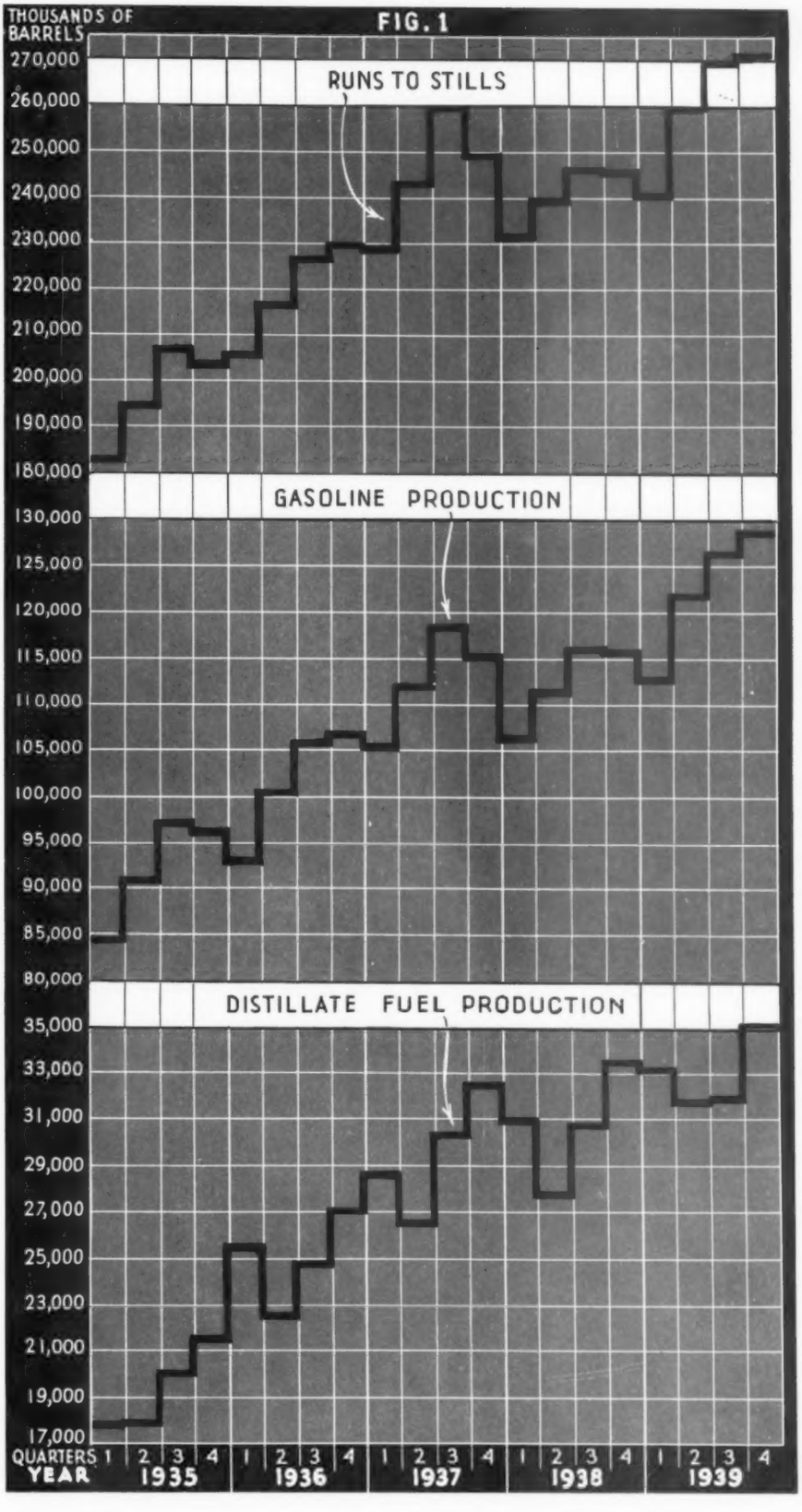
## SALES COORDINATION

Whether the refining industry has deliberately and willingly fostered the rapid increase in the demand for distillate fuel oils or whether it has been created by burner manufacturers and dumped into the refiner's lap for him to supply is a debatable question. Whatever the answer, it appears that no coordinated program has been developed for supplying the market for distillates along with that for gasoline.

To what extent the activities of the gasoline and fuel oil sales organizations are coordinated within the individual companies is not known, but as the industry is made up of its component companies, it would appear that the necessary coordination between these sales departments is lacking. In other words, there are two sales organizations in a company, and true to their tradition as salesmen each organization is bending every effort to increase its volume and passes its orders on to the refining department to be filled. The distillate fuel oil salesmen have done an exceptionally good job as salesmen and certainly no criticism can be leveled at them. If there is any fault to be found it must be laid at the door of management for permitting their salesmen to sell more than they can supply, and in not balancing their sales quotas with their refining schedules.

## FACTORS IN DEMAND

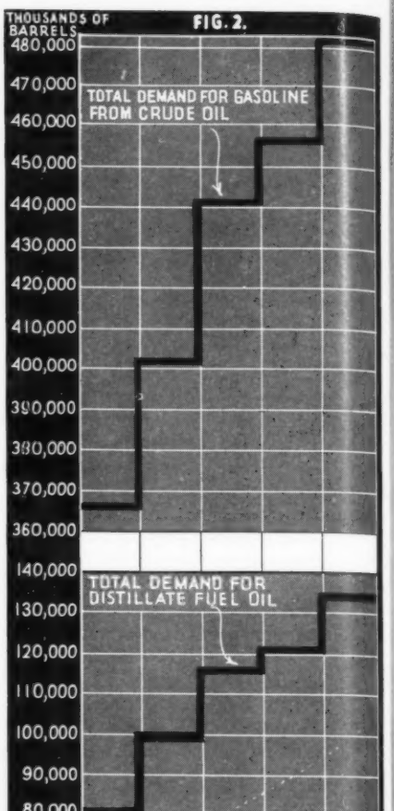
Unbalanced conditions which occur in an industry operating under a free economy are supposed to be brought back into a state of




*Runs to stills and gasoline production in comparison to distillate fuel oil production east of California by quarters from 1935 through 1939: note effect of seasonal fluctuation in fuel oil production on gasoline production.*

equilibrium by that famous cure-all, the law of supply and demand, and it is interesting to examine the situation to see whether the law of supply and demand has not been operating up to this time or whether it now is operating or is about to operate to restore the necessary balance. In examining the recent history of the oil industry, certain features are found to exist which while not entirely obstructing the functioning of this basic law, have resulted in its not operating to the same extent that it might in other industries.

In the first place, the consumption of gasoline is not affected to any appreciable extent by fairly substantial fluctuations in price. Secondly, at least within the limits which have existed up to the present time, the consumption of domestic heating oils is not affected by moderate fluctuations in price. Thirdly, it also might be mentioned that it has been the practice in the industry for many years to guarantee certain maximum prices for heating oils a year in advance. Fourthly, at least a majority of the companies in the industry have adopted the cost accountants' theory that costs should be allocated to the various products on the basis of the market value of the respective products. Thus, so long as the price of any one product is low with respect to the other, the cost of that product according to this theory is lower than the others. As the price of distillate fuels has always been less than that of gasoline (with minor exceptions over short periods), the gasoline has always been costed at a higher price than the distillate fuel oil and inasmuch as costs as a general principle represent the minimum platform for prices, there is an inherent tendency for the prices of the two products to maintain their same position with respect to each other.




*Relationship between consumption of gasoline and that of distillate fuel oil, east of California.*

## TABLE II

### Consumption of Distillate Fuel Oils

(Thousands of Barrels)

| | 1935 | 1936 | 1937 | 1938 | 1939 |
|---|---|---|---|---|---|
| **EAST OF CALIFORNIA** | | | | | |
| Heating oil 1 & 2 | 55,000 | 67,693 | 56,900 | 58,190 | 92,000[2] |
| 3 & 4 | | | 21,313 | 20,543 | |
| Range Oil | 1,800[2] | 2,000[2] | 2,481 | 2,542 | 2,800[2] |
| Diesel Fuel[1]—All Industries | 4,226 | 5,384 | 8,124 | 9,860 | 10,500[2] |
| Railroads | 1,000[2] | 1,000[2] | 1,006 | 896 | |
| Gas and Electric Power Plants | 2,000[2] | 2,000[2] | 1,977 | 2,330 | |
| Smelters, Mines and Manuf. | 3,000[2] | 3,500[2] | 4,079 | 3,787 | 10,000[2] |
| Army, Navy and Coast Guard | 100[2] | 100[2] | 115 | 138 | |
| Oil Company Fuel | 400[2] | 500[2] | 640 | 701 | |
| Miscellaneous Uses | 1,200[2] | 1,500[2] | 1,352 | 2,121 | |
| Unaccounted for | 6,226 | 6,162 | 3,013 | 1,115 | 587 |
| Total | 74,952 | 89,839 | 101,000 | 102,223 | 115,887 |
| **PACIFIC COAST TERRITORY** | | | | | |
| Heating Oil 1 | 1,000 | 2,166 | 3,022 | 3,655 | 4,000[2] |
| 3 | | | | | |
| Range Oil | ..... | ..... | 266 | 360 | 300 |
| Diesel Fuel[1]—All Industries | 11,948 | 11,845 | 13,780 | 11,344 | 12,000 |
| Railroads | | | 13 | 15 | |
| Gas and Electric Power Plants | | | 4 | 62 | |
| Smelters, Mines and Manuf. | 1,500 | 1,500 | 43 | 53 | 1,200[2] |
| Army, Navy and Coast Guard | | | 51 | 1 | |
| Oil Company Fuel | | | 31 | 71 | |
| Miscellaneous Uses | | | 1,447 | 772 | |
| Unaccounted for[1] | 3,371 | 2,593 | 2,816 | 1,107 | 445 |
| Total | 11,077 | 12,918 | 15,841 | 15,226 | 17,055 |
| **UNITED STATES** | | | | | |
| Heating Oil 1 & 2 | 56,000 | 69,859 | 81,235 | 82,388 | 96,000[2] |
| 3 & 4 | | | | | |
| Range Oil | 1,800[2] | 2,000[2] | 2,747 | 2,902 | 3,100[2] |
| Diesel Fuel[1]—All Industries | 16,174 | 17,229 | 21,904 | 21,204 | 22,500[2] |
| Railroads | | | 1,019 | 911 | |
| Gas and Electric Power Plants | | | 1,981 | 2,392 | |
| Smelters, Mines & Manuf. | 9,200 | 10,100 | 4,122 | 3,840 | 11,200[2] |
| Army, Navy and Coast Guard | | | 166 | 139 | |
| Oil Company Fuel | | | 671 | 772 | |
| Miscellaneous Uses | | | 2,799 | 2,893 | |
| Unaccounted for | 2,855 | 3,569 | 197 | 8 | 142 |
| Total | 86,029 | 102,757 | 116,841 | 117,449 | 132,942 |

[1]For purpose of this statement it has been assumed that all Diesel fuels are 100 percent distillate. This is not strictly true and in the California figures results in a total distillate consumption greater than the actual.
[2]Estimated by Author.

## TABLE II-B

### Consumption of Heating Oils, Distillates and Residuals—1934 to 1939, Incl.

(Thousands of Barrels)

| 1934 | 1935 | 1936 | 1937 | 1938 | 1939 |
|---|---|---|---|---|---|
| **DISTILLATE FUELS (Excl. Range Oil)** | | | | | |
| East of California | 55,000[1] | 67,693 | 78,213 | 78,735 | 92,000[1] |
| Pacific Coast Territory | 1,000[1] | 2,166 | 3,022 | 3,653 | 4,000[1] |
| United States | 56,000[1] | 69,859 | 81,235 | 82,388 | 96,000[1] |
| **RESIDUAL FUELS** | | | | | |
| East of California | 18,287[1] | 25,031 | 29,525 | 31,157 | 35,045[2] |
| Pacific Coast Territory | 2,566[1] | 4,367 | 5,857 | 4,778 | 6,955[2] |
| United States | 20,853[1] | 29,398 | 35,382 | 35,935 | 42,000[2] |
| **TOTAL DISTILLATE & RESIDUAL** | | | | | |
| East of California 58,383 | 73,287 | 92,724 | 107,738 | 109,892 | |
| Pacific Coast Territory 2,439 | 3,566 | 6,533 | 8,879 | 8,431 | |
| United States 60,822 | 76,853 | 99,257 | 116,617 | 118,323 | |
| **DOMESTIC BURNERS—TOTAL U. S.[3]** | | | | | |
| Sales—New Installations & Replacements | 156,727 | 224,850 | 218,874 | 158,856 | 241,000 |
| In use—end of year 1,014,113 | 1,154,960 | 1,355,793 | 1,543,797 | 1,657,942 | 1,860,000[1] |

Data from Bureau of Mines annual statements of Fuel Oil Consumption, except as noted.

[1] Estimate by Author.
[2] Estimate by "Air Conditioning and Oil Heat"
[3] From A. P. I. and Oil Burner Institute.

## SUMMARY

In an analysis of an industry so large as this one, it generally is difficult to separate the causes from the effects as there are intermediate phases which are effects from one viewpoint, but admittedly causes of other conditions. However, based on the foregoing considerations, it would appear that the causes might be enumerated as follows:

1. The failure of refiners or the physical inability of their equipment to permit taking from the crude oil an increasingly larger percentage of distillate fuel oil.

2. The failure of the companies properly to coordinate their gasoline sales with the distillate fuel oil sales.

3. The low response in the demand for gasoline and distillate fuel oils to price fluctuations.

and that the effects, that is, the present condition, might be summed up as follows:

1. The demand for distillate fuel oil is growing at a much larger yearly percentage increase than is the demand for gasoline.

2. The percentage yield of distillate fuel oil is not keeping pace with the demand for

that product and over the year 1939 lagged so far behind that had refiners not been able to go into distillate fuel stocks for their supplies, there would have been produced at the yields actually realized in that year an additional 10,000,000 bbl. of gasoline over and above the 8,600,000 bbl. which were added to storage.

3. By the end of the winter, refiners will have reduced their distillate fuel stocks to what may well be considered the very lowest economic level for convenient operation. They cannot fill out another year's requirements from stocks.

4. As a result of the foregoing conditions, gasoline inventories have mounted higher and higher.

5. Unless balance is restored the condition will get worse year by year.

6. Recorded consumption of crude oil has been in excess of the true demand and the industry's estimates of the amount of crude oil required to supply the demand for products have been higher than the amount actually required.

## SUGGESTED REMEDIES

At various times it has been suggested that balance should be obtained by remedies directed at cause (1), namely, the failure or inability of refiners to increase the percentage yield of distillate fuel oil from crude. One suggestion was to reduce the runs to stills to the amount required for the gasoline production and let the distillate fuel oil consumers look out for themselves in any way they could. This is hardly practicable because aside from the contractual obligations of the companies the industry has a social obligation to its consumers, and in any event, the companies, themselves would not see the public want for fuel oil. Another suggestion made recently was that crude oil production should be drastically cut so that refiners would not have the crude to run. This likewise is hardly practicable.

A more obvious remedy suggested in the fall of 1939 was that the yield of distillate fuel oil be raised arbitrarily. Such a practice, however, is fraught with difficulties and there seems to be no uniform opinion as to the practicability of it. Refiners who have low level cracking facilities seem to have greater flexibility than the others who insist that they must crack all of their intermediate distillates to maintain present standards of gasoline. Those who maintain that yields during the winter months cannot be further increased, find considerable support in the figures for the last quarter of 1939. During that period there certainly could have been no desire on the part of refiners to make gasoline unnecessarily. At December 31st the refiners already had as much gasoline as they will actually require on March 31, 1940. On the other hand, heating oil inventories were below normal for that season of the year. Consequently, the conditions presented all of the inducements to raise the yield of distillate fuel and suppress the yield of gasoline. Yet during the fourth quarter of 1939 the average over-all yield of distillate fuel East of California was only 13.0 percent, although during the corresponding period of 1938 it was 13.6 percent. Aside from plant facilities and the quality of products, the question of yields necessarily is governed to a large extent by the market price of products; operating programs are controlled by the ultimate profit that can be realized from the products assuming that a market can be obtained.

Assuming that refiners cannot increase their winter yields, it nevertheless does appear possible that at least the present market for distillate fuels could be adequately met if refiners would so adjust their schedules as to realize the same yield of distillate fuel oil from the crude oil in the summer time as in the winter time. Table V has been prepared to show the yield of gasoline and distillate fuel oil by quarters for the last five years. From it, it will be seen that there is a variation of from 1½ to 2 percent in the yield of distillate fuel oil as between the summer and winter months. The demand for gasoline from crude oil (exclusive of all natural gasoline) over the year 1939 amounted to 482,000,000 bbl., which at the average yield of 47.2 percent would have required 1,020,000,000 bbl. of crude. Had the distillate fuel oil yield been maintained at 13.4 percent—the average of the first and fourth quarters of 1939—the output of distillate fuel oil would have amounted to 136,600,000 bbl., an amount slightly greater than the total demand for distillate fuels in 1939.

### TABLE III

**Relationship Between Yields and Consumption of Distillate Fuel Oil 1935 to 1939**
**(East of California)**

| | Yield of Dist. Fuel Oil | | Domestic Cons. of Dist. Fuel Oil | | Consumption of Dist. Heating Oil | | Exports of Dist. Fuel Oil | |
|---|---|---|---|---|---|---|---|---|
| | Percentage | Increase Over Previous Year | 1,000 Bbl. | Increase Over Previous Year | 1,000 Bbl. | Increase Over Previous Year | 1,000 Bbl. | Increase Over Previous Year |
| 1935 | 9.81 | | 74,952 | | 55,000 | | 1,932 | |
| 1936 | 11.36 | 15.8% | 89,839 | 19.9% | 67,693 | 23.1% | 9,896 | 42.8% |
| 1937 | 12.01 | 5.7% | 101,000 | 12.4% | 78,213 | 15.5% | 15,553 | 57.2% |
| 1938 | 12.73 | 6.1% | 102,223 | 1.0% | 78,735 | 0.1% | 18,275 | 17.5% |
| 1939 | 12.67 | | 114,880[1] | 12.4% | 92,000 | 16.8% | 19,259 | 5.3% |
| | | | 115,887[2] | | | | | |
| Percent Inc. 1939 over 1935 | | 29.15% | | 53.27% | | 67% | | 177.82% |
| Ave. An. Increase—4 years | | 6.6% | | 11.3% | | 13.7% | | 29.1% |

[1] For comparison with prior years.
[2] New basis using Refinery and Terminal Stocks.

### TABLE IV

**Relationship between Consumption of Gasoline and that of Distillate Fuel Oil, 1935 to 1939**
**(East of California)**

| | Total Demand for Gasoline from Crude Oil[1] | | Total Demand for Distillate Fuel Oil | |
|---|---|---|---|---|
| | 1,000 Bbl. | Increase over previous year | 1,000 Bbl. | Increase over previous year |
| 1935 | 366,100 | .... | 81,007 | ..... |
| 1936 | 401,636 | 9.7% | 99,110 | 22.3% |
| 1937 | 440,112 | 9.6% | 115,827 | 16.9% |
| 1938 | 455,761 | 3.6% | 120,177 | 3.8% |
| 1939 | 481,785 | 5.7% | 133,506[2] | 11.1% |
| | | | 134,513[3] | |
| Percent Incr. 1939 over 1935 | | 31.60% | | 64.81% |
| Average Annual Increase—4 Years | | 7.1% | | 13.3% |

[1] Demand for Gasoline from Crude as used here is Total Demand (Domestic and Export) reduced by Miscellaneous Supply (Benzol and Natural used direct) and further reduced by all of the natural used for blending inasmuch as the natural gasoline ordinarily is not added until shipment and a negligible amount went into the stock increase.
[2] For comparison with prior years.
[3] New basis using Refinery and Terminal Stocks.

### TABLE V

**Runs to Stills and Production of Gasoline and Distillate Fuels—East of California 1935-1939**
**By Quarters**
**(Thousands of Barrels)**

| | Runs to Stills | Gasoline Prod. Excl. Nat'l. Amount | Gasoline Prod. Excl. Nat'l. Yield | Finished Gasoline Output plus Nat'l. Amount | Finished Gasoline Output plus Nat'l. Ratio to crude intake | Distillate Fuel Output Amount | Distillate Fuel Output Yield |
|---|---|---|---|---|---|---|---|
| 1935—First Quarter | 183,104 | 84,749 | 45.28 | 88,540 | 48.36 | 17,850 | 9.75 |
| Second Quarter | 194,226 | 90,929 | 46.82 | 94,113 | 48.46 | 17,878 | 9.67 |
| Third Quarter | 206,897 | 97,212 | 46.99 | 102,502 | 49.54 | 20,000 | 9.67 |
| Fourth Quarter | 203,712 | 96,200 | 47.22 | 103,366 | 50.74 | 21,577 | 10.59 |
| Year | 787,939 | 369,090 | 46.84 | 388,521 | 49.31 | 77,305 | 9.81 |
| 1936—First Quarter | 205,263 | 93,212 | 45.41 | 96,639 | 47.08 | 25,458 | 12.40 |
| Second Quarter | 216,400 | 100,342 | 46.37 | 104,883 | 48.47 | 22,524 | 10.41 |
| Third Quarter | 227,256 | 105,963 | 46.63 | 111,927 | 49.25 | 24,841 | 10.93 |
| Fourth Quarter | 229,908 | 107,161 | 46.61 | 114,420 | 49.77 | 27,005 | 11.75 |
| Year | 878,827 | 406,678 | 46.28 | 427,869 | 48.69 | 99,828 | 11.36 |
| 1937—First Quarter | 228,263 | 105,416 | 46.18 | 110,009 | 48.19 | 28,651 | 12.55 |
| Second Quarter | 243,126 | 112,258 | 46.17 | 117,919 | 48.50 | 26,523 | 10.91 |
| Third Quarter | 259,268 | 118,563 | 45.73 | 126,194 | 48.67 | 30,154 | 11.63 |
| Fourth Quarter | 249,638 | 115,302 | 46.19 | 125,052 | 50.09 | 32,413 | 12.98 |
| Year | 980,295 | 451,539 | 46.07 | 479,174 | 48.88 | 117,741 | 12.01 |
| 1938—First Quarter | 232,297 | 106,219 | 45.68 | 112,962 | 48.57 | 30,909 | 13.31 |
| Second Quarter | 239,489 | 111,559 | 46.56 | 117,190 | 48.92 | 27,630 | 11.54 |
| Third Quarter | 246,641 | 116,681 | 47.56 | 123,426 | 50.25 | 30,735 | 12.51 |
| Fourth Quarter | 246,254 | 115,971 | 47.09 | 124,906 | 50.72 | 33,517 | 13.61 |
| Year | 964,681 | 450,430 | 46.74 | 478,484 | 49.63 | 122,791 | 12.74 |
| 1939—First Quarter | 240,318 | 112,692 | 46.89 | 118,463 | 49.29 | 33,184 | 13.81 |
| Second Quarter | 259,873 | 122,119 | 46.99 | 127,521 | 49.07 | 31,658 | 12.18 |
| Third Quarter | 263,845 | 126,802 | 47.17 | 132,726 | 49.37 | 31,799 | 11.84 |
| Fourth Quarter | 270,150 | 128,747 | 47.67 | 137,441 | 50.88 | 35,006 | 12.96 |
| Year | 1,039,186 | 490,360 | 47.19 | 516,151 | 49.67 | 131,647 | 12.67 |

It has been the practice of the industry for years past to control its crude intake in such a manner as to provide adequate gasoline stocks. Such stocks normally increase from October to March inclusive and are drawn upon from April to September. In recent years there never has been a shortage in the third quarter of the year (that is, the second half of the high consuming season) which required an increase in refinery throughout to meet it. If the present distillate fuel market is to be retained and will pay its own way, there is no reason why refiners should not be willing to store this product and accumulate over the summer months the necessary inventories to permit their carrying on their fuel oil business conveniently and economically during the winter.

Many of the suggestions for securing balance that have been made in the past, including those mentioned herein and others, doubtless were well intended and had they been followed, would have contributed to the reestablishment of equilibrium, but as the lack of balance can be traced to so many causes, it appears that no one scheme or remedy in itself will be entirely effective and that a number of modifications and changes in practices are indicated. It might be asked whether the approach should be along the line of balancing the respective supplies or along the line of balancing the respective demands. Obviously, as gasoline is the primary product of the industry and distillate fuel oil is the secondary product, the answer must be found in balancing the supply of the secondary product within the limits of the demand for the primary product

It already has been shown that over the year 1939 the crude oil required to meet the demand for gasoline would have supplied fully the demand for distillate fuel oil if the yield of the latter product had been maintained over the summer months at the same percentage as was realized during the winter months. It follows, therefore, that the demand for gasoline and the normal seasonal fluctuations in stocks of that product constitute a valid basis for determining crude oil demand over any twelve months' period. Admittedly, with runs to stills and crude oil supply so determined, certain modifications and changes in practices will be required, but these in any event are long overdue.

First, the proper degree of coordination should be had as between the two sales organizations, the one handling gasoline, and the other handling distillate fuel oil. The refining department should calculate the amount of distillate fuel oil that can be made conveniently and economically along with the required gasoline production and the fuel oil sales department should then be instructed to sell the available output of distillate fuels in the most attractive market.

Secondly, insofar as practicable, refining schedules should be budgeted on a year round basic, and the required supplies of distillate fuel oil so far as they can be foreseen should be accumulated over the year rather than waiting until the fourth quarter.

Thirdly, inasmuch as the social obligation of the industry to the users of the lighter domestic heating oil is greater than to those users of the heavier distillates who conceivably could use a residual fuel oil, every effort should be made to maintain the highest possible yield of the lighter distillate fuel even to the extent, if necessary, of discouraging any further expansion in the market for the heavier distillates.

Fourthly, conservation principles such as already govern crude oil production might well be followed in adopting a refining program. Estimates of demand, crude oil production, and runs to stills should be scheduled on the basic principle that the demand for petroleum products will be met from the least amount of crude oil that is required for efficient and convenient operation.

# Solid Opposition in Hearings May Block FEDERAL CONTROL

THE RECORD of the Cole subcommittee of the House Interstate Commerce Committee on the bill drafted in the Department of the Interior to extend federal control to the production of petroleum stands virtually complete after three weeks of hearings last month which found members of the Interstate Oil Compacts Committees, officials of state regulatory agencies and representatives of the industry all in solid opposition to the measure.

In the light of current efforts to curtail the congressional program there appears to be little indication that the measure in present or modified form, will take its place on the legislative agenda slated for final and favorable action before Congress adjourns.

On the whole, the hearings, begun last November when Secretary Ickes presented the government's case, and concluded last month with a summarization of the industry's objections by J. C. Hunter of Abilene, Tex., president of the Mid-Continent Oil and Gas Association, served to emphasize the direct issue between federal and state regulations as a means of governing orderly production and promoting genuine conservation.

Meanwhile the hearings were highlighted by the testimony of Governor Leon C. Phillips, of Oklahoma, chairman of the Oil Compact Commission, heading a group of oil state executives in opposition to the bill to be offset almost immediately by the introduction of a report by the Federal Power Commission holding that neither state regulation nor compact agreements have served to prevent waste.

This report prepared by C. C. Brown, principal engineer of the Power Commission's division on gas and electric resources was read into the record by Representative Cole of Maryland, chairman of the subcommittee. It was made under the provisions of the Natural Gas Act, he said, and amounted to an investigation of the operation of the state oil compacts.

> "Proper and adequate conservation of petroleum, natural gas, and other hydrocarbons, and the prevention of wastage thereof," said the report, "cannot be satisfactorily accomplished through state control, either individually or by means of state compacts. The history of compact here reviewed discloses nothing of a tangible nature that has been accomplished either in conservation, prevention of waste, or even in standardization or improvement of state legislation dealing therewith.
>
> "The State of Illinois, one of the original signatory states in the compact, has, upon reaching the status of a major petroleum producing state, dropped out of the compact, and has not yet enacted conservation legislation. Conservation legislation in other states is either inadequate or ineffectually administered. State compacts similar to the one reviewed have no authority, no power and no means of enforcing anything. They can neither retain nor compel membership of oil or gas producing states. Neither can they prescribe or enforce State legislation. Under these conditions they are powerless to accomplish anything other than interchange of information and suggestions."

Governor Phillips, who summed up the statements previously made by executives of the other oil-producing states in opposition to the bill, suggested the Brown report may have had its origin in the Department of the Interior. Unless it contained references to the "inefficiencies" of federal regulation on Indian lands, notably in the Osage reservation in Oklahoma, he said, he wanted to place in the record some information of his own on the subject.

In this connection Hiram N. Dow, a member of the Compact group from New Mexico denied the import of the report asserting that state conservation is now far superior to the conservation methods practiced by the Interior Department on federal lands directly under federal control. He pointed out the admission of the energies report of the National Resources Board, frequently cited in support of the bill, that price was a factor in waste—a suggestion which led to committee questions as to the reasons for the August shutdown in the states, members to the Compact.

The questions, however, were directed at a subsequent witness, A. Andreas, state geologist and member of the New Mexico Oil Conservation Commission. He said that as soon as posted price of crude oil had been cut

by major companies, members of the compact commission "deduced" that there was overproduction. Under New Mexico state law, he explained it is mandatory to order cessation of production if there is any imminence of waste resulting from production in excess of market demand.

The constitutionality of the proposed legislation was attacked in a brief filed with the committee by Colonel Ernest O. Thompson, of the Texas State Railroad Commission and outlined before the committee in Colonel Thompson's absence by Jack Blalock of Houston, counsel for the Compact Commission. It emphasized Supreme Court decisions prior to 1937 to support the view that there was not the slightest reason to believe regulation of the production of oil is within the commerce powers of the federal government. The pending bill was compared to the first Bituminous Coal bill in which the Court had noted that what was true of coal production also was true of oil production.

The case of the petroleum industry was presented by 14 witnesses over sessions covering several days during which the legal history of the conservation of oil by states was traced, the engineering steps and developments to prevent waste noted and the testimony of the government witnesses in support of the bill commented on at length. The representatives of the industry also submitted an argument against the constitutionality of the proposed measure prepared by Tom Anglin, of Holdenville, Oklahoma, and former Governor William J. Holloway of Oklahoma City.

Summarizing the industry's position Mr. Hunter said:

"Federal control as provided in this proposed legislation would make it possible for a single government official arbitrarily to dominate a great basic industry and would precipitate reprecussions in this and other industries. We think that the industry and the states can do better job of conservation than can any federal agency."

Like Governor Phillips the witness said the premise that federal control of the oil industry is necessary to maintain the national defense is unsound and that no emergency exists in oil.

"The record discloses" continued Mr. Hunter, "that the known reserves of the nation are constantly increasing and that progress in their conservation is rapid and sustained. The industry can readily supply without waste any requirements of the army and navy and for all civilian uses during war. The presence of other fuel yielding resources convertible into oils at only slightly increased prices, such as shales and coal, in known quantities sufficient to meet the fuel needs of the nation for thousands of years, completely negatives any basis for the claim that the national defense requires Federal control of oil and gas production.

"Witnesses from the army and navy appearing before this Committee in November 1939, testified that during the World War the oil industry adequately supplied the oil needed for national defense. This was at a time when our developed reserves were very much smaller than now exist, and when the principles of conservations now in operation were wholly unknown.

Recalling that genuine conservation efforts in petroleum industry are only 15 years old, he emphasized the body of law covering the subject already built up, and the existence of adequate conservation laws in Oklahoma, Texas, New Mexico, Kansas, Louisiana, Arkansas, Michigan, Mississippi and Colorado in which states are located 74.08 percent of the country's reserves. In addition he added real progress in conservation has been made in California in which are located 18 percent of the nation's reserves.

He listed the industry's achievements in conservation in this short period as follows:

"The acquisition through research and practical operation of fields under conditions of reservoir control of a vast amount of knowledge concerning the behavior of the oil and gas reservoirs and of conservation possibilities and practices; through the expenditures of millions of dollars upon engineering and engineering research, well completions are now made at depths, in thin sands, and under conditions that would have been impossible only a few years ago, thus opening large reserves hitherto not possible of recovery, and making it possible to supply the requirements for oil under conditions of sharp reservoir control in our oil fields, which is the primary factor in waste prevention. The use of electrical logging, gun perforating, setting of packers, and the use of squeeze cementing and other techniques to reduce gas-oil and water-oil ratios have become routine. Waste from blow-outs and cratering have been reduced to a minimum; wide spacing and increased reserves have been utilized in bringing about reservoir control by reducing the rate of recovery from the field, thus preventing premature encroachment of water and by-passing of oil by gas and enabling the fuller utilization of the natural energies of the pool.

"This program of conservation carried on by the industry in cooperation with and under regulations of the state conservation agencies has resulted in reducing the underground waste of oil from an estimated 25 percent to 30 percent under open-flow methods formerly employed to about one percent for the nation under present methods of control and operation."

# Problems Of Wartime Petroleum Regulation In GREAT BRITAIN

## By Alec H. Day

**Drastic Curtailment of Fuel Supplies Has Disrupted Oil and Motor Trades With Serious Effect on Other Business and a Heavy Decline in Government Revenue.**

NEVER before has the oil industry in Great Britain faced so sudden and complete change of operating conditions as took place with the coming of war, resulting in the formation of the Petroleum Board (Petrol Pool) and the suddenly imposed restriction of consumption. The importance of this radically new marketing arrangement is emphasized by the fact that this country is the industry's largest sales market outside of the United States. Consequently the new conditions will make their dent in international petroleum history. But the way things are working out a danger

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*London bus driven by gas producing plant which may be seen attached to the rear of the vehicle. Work on petroleum substitutes has been pushed in war-time England to conserve oil and foreign exchange.*

© Fox Photos, Ltd.

*War-time contrast on the Great South Road leading out of London: to the left, normal summer traffic before the war, and right, since petrol restrictions came in force.*

exists that the government, in its urgent and essential endeavor to reduce business and private consumption to the absolute minimum may ultimately prove to be even a greater sufferer than the oil industry.

Prompt action to conserve petroleum supplies, man power and foreign exchange was dictated by the expectation that the war would enter immediately upon an active phase. This has not happened and as the situation stands there is a serious possibility that the national interest, to say nothing of the trade interests abroad, may be injured through the curbing of activities that provided, directly and indirectly, a great amount of tax revenue.

The experience of the past six months has been instructive. Perhaps in no other way could so clear a realization have been reached of the important place that the oil industry and the closely related motor industry have come to occupy in British life and industry. As time goes on a study by the authorities concerned of the complications and losses resulting from the sweeping application of drastic restrictions may be counted upon to lead to some modification of existing regulations to the advantage both of the public and the government itself.

It is clear that in the consideration of a possible lightening of restrictions shortage of supplies is not a factor. Owing to the curtailment of private use consumption has been less than in the pre-war period, even with military requirements included. Oil has continued to arrive from overseas in steady volume. The supply position was strengthened during the first five months of the war by the capture of some 850,000 bbl. consigned to Germany which has more than offset British tanker losses. The dominating reasons for miniminizing the use of petroleum have been the desire to lessen the risks of ocean transport and to economize exchange.

With due allowance for these considerations some of the effects of war-time motoring restrictions are causing serious concern to those who are working for efficient and vigorous motor transport. International petroleum companies, in common with the users of the road and the British motor trade, have a big stake in maintenance of the country's road transport at as high a level of activity as is consistent with a maximum war effort. It is now being questioned whether government road policy is, in fact, contributing to effective conduct of the war, or whether motor transport restrictions may not involve too high a price for any advantage gained through the savings in exchange.

Methods adopted are already causing serious disturbance to Britain's sources of petroleum imports, and may cause still greater dislocation in course of time. Admitting the urgency and real need of official regulation to meet war-time problems, the actual steps taken nevertheless have created a position bordering on disaster for the retail end of the motor spirit industry of the United Kingdom.

Government policy in relation to motoring has been made clear by statements from Cabinet Ministers. Sir John Simon, Chancellor of the Exchequer, stated in December last that it was not the government's policy to encourage or allow private motoring to continue, but that it was intended to provide sufficient motor spirit through the rationing system to meet the needs of users of cars for professional or business purposes. Actual working of the rationing system has proved that in implementing its policy the government has effectively restricted not only private motoring, but also motoring for business purposes. With private motoring no distinction has been made between purely pleasure driving and normal car operation which has become so great a part of the British people's lives since the last war.

Road hauliers complain that the flat rate of 50 percent of normal consumption is totally inadequate as a basic ration, and that supplementary rations have failed to correct the position owing to restrictions placed on allocation of additional supplies. Many firms employing car-using commercial travellers have been obliged to dismiss their outdoor staffs through being denied sufficient motor spirit. Taxi and bus services have been considerably cut down, although these are being slightly improved.

Reduction of motor spirit rations is not the only means applied to restrict the use of cars. Increase in the car tax from 15s. to 25s., included in the April (1939) Budget to help finance the pre-war rearmament program, came into operation on January 1, 1940, and in spite of strong appeals the government has refused to modify it. Coupled with the increased cost of motor spirit the big rise in car tax represents a heavy overhead on the reduced mileage allowed by normal and supplementary rations, and thus has involved a percentage expense for the motorist out of proportion to the actual increase in the tax. Large numbers of motorists have refused to bear the additional burden, and have laid up their cars pro tem or for the duration of the war. Then again, abandonment of the road construction program does not foster increased use of motor vehicles. Private motoring has been cut 75 percent.

Such discouragement of the use of cars may be considered a necessary war-time measure, but naturally it is having a serious effect on business efficiency. Transport by car has become an indispensible factor in national life, and many private cars are used for business as well as for general living activities and for pleasure. Restriction does not differentiate between the business call, a personal or family time-saving trip and the purely pleasure trip, and all are thus made to suffer through the curtailment of driving.

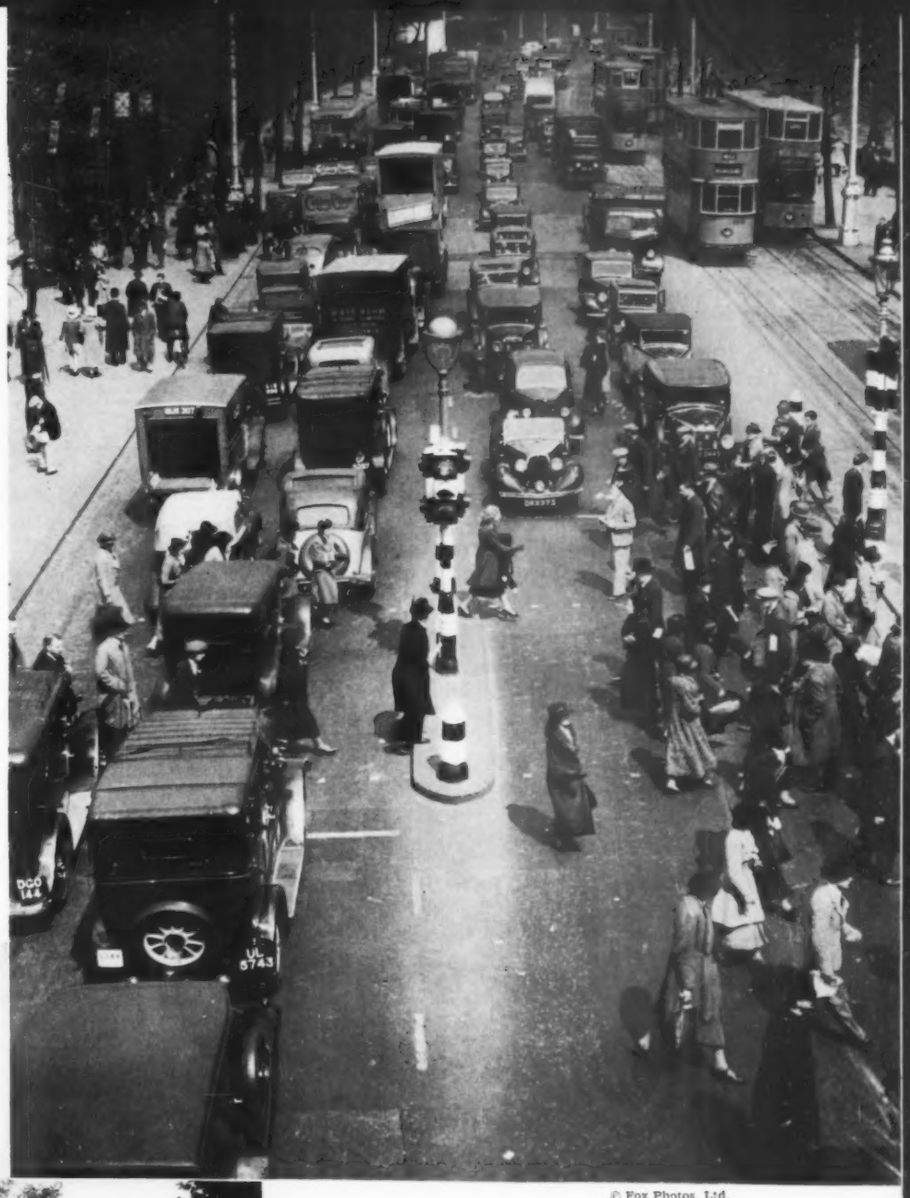
During war, the sound morale and optimistic spirit of the nation is as vital as fighting. For their preservation it is desirable that the normal activities and social life of the people at home should continue as long as practicable, just as the troops at the front and under training must be given lighter moments by entertainment. During the previous war motoring had not reached the point where it formed a definite part of the life of the people but was a sport and convenience of the rich. Nor was the motor vehicle an appreciable factor in commercial transport. Yet, although the present war has not reached anything like the same serious stage as in 1915, and al-

though the actual sinkings of tankers by submarines and mines have not yet made tangible inroads on imports of petroleum supplies, government restrictions in Great Britain and many other European countries have gone much further.

Some members of the British oil industry, while fully recognizing the necessity of certain restrictions and for a tightening-up to the last degree when the need arises, hold that the national determination to carry the war to a successful conclusion should be stimulated in every possible and reasonable way, and that enough detergent effect on morale and business has already been produced by the blackout, which in itself has extensively reduced night motoring by private owners and possibly has been nearly as great a factor in causing cars to be laid-up as either the petrol rationing or the increased horsepower tax.

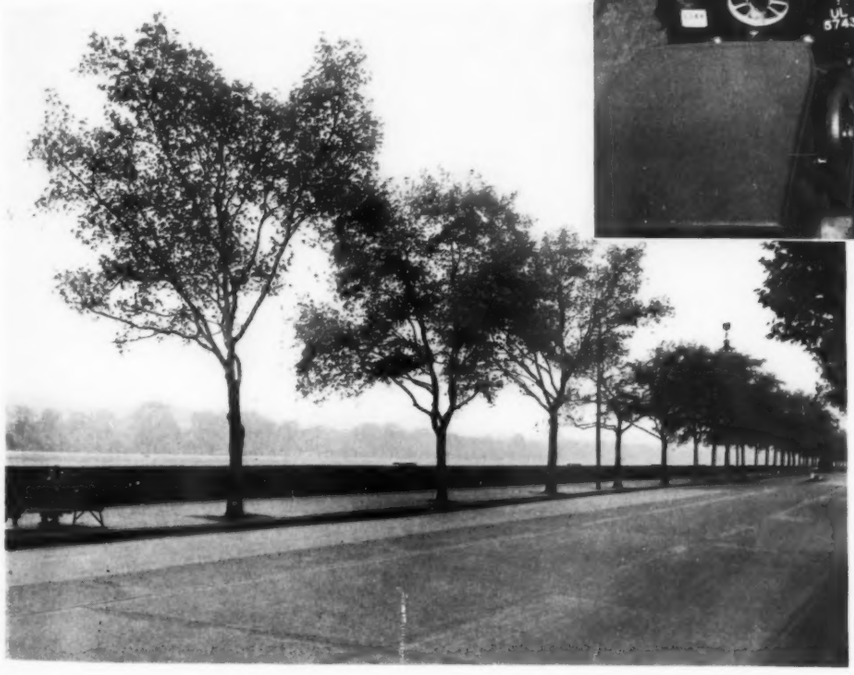
Reduced and indefinite train services; restricted city and county bus services, in conjunction with the blackout, have all helped to make local travelling more difficult. The average man and woman simply cannot find the extra time now needed to indulge in visiting or other social activities which involve trips of more than a few miles. Hence, the amount of social intercourse which forms such an integral part of life and of the cheerfulness of the nation already has dropped to a comparatively low level, and consequently must have a depressing effect. Without question a motor car saves valuable time and time means money, even in social affairs. The present quiet situation may undergo a complete change before this appears in print, trebling the war requirements of petrolem products, but at the moment Britain is fighting an economic war and a war of nerves, both of which are to an extent waiting games, and make the maintenance of ordinary activities of more than usual importance.

How far restrictions have cut into the use of the car in Britain can be illustrated statistically by the figures of new registrations of motor vehicles. Ministry of Transport returns for December, 1939, with percentage changes added, are set forth in the accompanying tabulation.



*Petrol rationing has cut British motoring by over 70 percent; both pictures show the Thames Embankment, the one on the right having been taken last summer before the war started, and the one below being a common sight since petrol rationing became effective.*

© Fox Photos, Ltd.



Reduction in the aggregate of new registrations in December is not a temporary movement. Previous months of the war showed the same trend, private cars put on the road for the first time in November being actually 84.9 percent less than in the corresponding month of 1938.

**Motor Vehicles Registered for the First Time in Great Britain**

| | December, 1938 | December, 1939 | Percentage increase or decrease |
|---|---|---|---|
| Private cars | 26,018 | 4,668 | —82.1 |
| Motor cycles | 2,178 | 707 | —67.5 |
| Hackney vehicles | 577 | 194 | —66.4 |
| Goods vehicles | 5,504 | 2,844 | —48.3 |
| Other vehicles | 904 | 1,182 | —30.8 |
| Total | 35,181 | 9,595 | 72.7 |

Effects of the government's policy on the retail motor trade have been serious. This trade deserves well of the country as one of the most energetic and efficient industrial growths of the past twenty years. While conditions may be regarded as regrettable but necessary, certain resultant facts must be faced. Motor filling stations over a period of years have developed from small and sometimes unsightly structures into excellent and

presentable service establishments. Before the outbreak of war the retail end of the motor and petrol retailing industries employed 200,000 workers, of whom about 80 percent were skilled operatives. Its pay-roll was approximately £1,000,000 a week. Capital employed by the trade in premises, equipment and stocks of vehicles and spare parts has been estimated at £150,000,000 and the annual turnover at over £300,000,000. Of an estimated British consumption of motor spirit of 40,000,000 bbl. per annum, 24,000,000 bbl. were supplied through the retail motor trade.

Since the outbreak of war, and the imposition of motoring restrictions, domestic sales of both new and second-hand cars and commercial vehicles have practically ceased. Sales of motor spirit through retail stations have fallen by between 70 and 80 percent. Owing to the decline in car use thus indicated, income from repair work, servicing, and sales of accessories has been cut down by at least 70 percent. These figures indicate the effect on the trade. Stocks of vehicles alone are estimated by the Motor Trade War Executive to have fallen in value by £8,000,000. Large numbers of employees have had to be dismissed, and a highly skilled labor force has been largely disbanded. Many of course, have found their way to war-work jobs or have joined-up and their pay is now being found by the government, not by the taxable motor industry.

Although vigorous and progressive, the retail motor trade has also been highly competitive, with the result that even in peace time the profit ratio was always too low to allow a general building-up of substantial financial reserves against unforeseen contingencies. One of the first results of the government attitude to the trade has been that even some of the first-class concerns have been forced into liquidation. In some cases the situation may be alleviated by government orders for the repair of vehicles used by the British expeditionary force and since returned to England.

An individual example of this aspect of the depression was provided by statements made at the unopposed hearing of a recent winding-up petition against Moon's Garages Limited. The company owned one of the biggest chains of motor garages in the country, operating 22 excellent establishments and selling about 150,000 bbl. of motor spirit a year. Counsel told the court during the hearing that war-time restrictions had turned a profitable business into one losing about £1,000 a week. One oil company is a creditor to the tune of nearly £6,000.

Influences making for depression in the retail motor trade, with its servicing and spirit selling affiliates, has a far from negligible effect on the country's internal finances. Aside from the income tax and other revenue derived from the trade, returns from motor vehicle taxation and spirit duty amounted in 1938 to nearly 10 percent of the total national revenue.

In his 1939-40 Budget the Chancellor estimated income at £23,000,000 with an increase in the following year to £28,000,000, on the basis of the 25s. horse power tax. These figures have now been drastically revised, and trade observers put the revenue at no more than £20,000,000. Motor spirit duty realised a revenue of £51,600,000 in the fiscal year 1938-39, and the estimate for 1939-40 was £54,000,000. With private and commercial consumption of spirit down by over 70 percent since the beginning of the war, this estimate certainly will not be reached. A reduction of something like £40,000,000 in revenue from car tax and motor spirit duty alone may be anticipated if current conditions are allowed to continue.

Economists point out that such a shortfall, however, would represent only a part of the revenue ultimately lost to the Exchequer. Income tax receipts from the motor trade must soon be greatly reduced, and further income tax will be lost through the low level of employment in the industry. Local authorities are losing rating income from closed-down garage and service station premises, and retail trade is having its taxable capacity impaired by the curtailment of shopping excursions by car. Hotels, restaurants and other businesses are suffering severely from losses in trade due to the drop in private and business motoring, and their income tax payments will be lower.

Another source of taxable profit which is lost by the discouragement of motoring is that arising from the complete cancellation of all publicity expenditure by oil companies and other interests associated with motoring. The revenue of all sorts of allied publicity businesses, such as agencies, printers and engravers has been reduced. Incomes of motor, garage and oil trade magazines have suffered correspondingly.

As far as the petroleum industry is concerned, the absence of advertising individual brands of motor spirit may effect a temporary reduction of operating expenditure. Those oil men who are no longer enamoured of the plan feel that it is a saving which will prove in the end to have been purchased very dearly. Motor spirit in Britain, supplied as "Pool" spirit, is already becoming just "petrol" to the individual motorist, instead of bearing some well-known brand-name that the motorist had learned to trust.

That means that the former brands are already being forgotten, and the millions of pounds spent building up reputations are now thrown down the drain. Their disappearance from the public mind means the dissipation of an incalculable value of goodwill, built up by an immense expenditure of thought, labor and money over a period of many years.

Regardless of all its war-time advantages, the Petroleum Pool is in the minds of some oil men, the biggest step towards a permanent marketing monopoly ever undertaken in the United Kingdom, and they feel that the policy of completely eliminating brand names is fraught with danger for the future. A monopoly established in Great Britain after the war would be a disaster for the industry and for consumers. Prices would be higher internally and the quality of the products would drop, as evidenced by the functioning of every oil monopoly yet to be placed in operation.

Cessation of the activities referred to above is by no means the only example of reduction in business turnover and therefore in tax potential. This reduction extends outward in vicious circles from the depression in motor transport. It is pointed out that motoring restrictions are thus handicapping the country's internal war finance, not only by reducing business efficiency but also by cutting down the earnings constituting the nation's tax fund.

Aside from this immediate and material loss, current government policy is making a heavy draft on the future of motor transport. Repairing, servicing and retail selling are essential adjuncts to the motor manufacturing industry, and the absence of a high level of internal business may handicap the industry's effort to develop export markets. If the retail motor trade is decimated as seems likely unless conditions are altered, possibilities of post-war export trade for British motors will be seriously impeded, regardless of the recent improved motor vehicle export figures.

Measures such as a fuller government use of the retail motor trade's spirit storage and repairing facilities have been suggested as a remedy for current depression, but the government's reply is that ordinary storage is ample for the country's needs. Probably nothing short of a larger petrol ration and reduced car tax will suffice to put the trade really on its feet, and even this may come too late to prevent further serious damage.

Government spokesmen have made no secret of the considerations underlying its attitude to motoring, although the official attitude has been to stress the need for conserving Britain's foreign exchange resources rather than the more important question of avoiding any unnecessary endangering of the lives of those who man the tankers. Except possibly for the latter reasons there appears to be no serious barrier to some liberalization of rationing with the proviso that the unit would be reduced immediately any strain on shipping was imposed by the requirements of the fighting services.

Undoubtedly the convoy system reduces a tanker's annual carrying capacity by nearly one-third. While many more tankers are now building, it must not be forgotten that almost the entire American owned oil-carrying fleet has been forced to remain in other services, and that the mine and submarine danger, though recently greatly minimized, is nevertheless keeping many neutral tankers out of the war zone. This unsatisfactory position probably will be alleviated by changing the direction of petroleum imports through increasing the supply ration from the West rather than from the East, thus increasing existing tankship capacity by over 10 percent due to shorter voyages. Secondly, by temporarily reducing the home refining output, other than production from coal by hydrogenation and by low-temperature carbonization, the capacity of the fleet will be increased by a further 10 percent through eliminating refinery waste. It is now recognized that had France spent thousands of millions of francs on tankers instead of on her vast domestic refinery program, the present supply position

would be extraordinarily good and free from any near-future concern.

As regards foreign exchange, the actual amount of gold, exchange and realizable securities available to the British Treasury never has been announced, but was estimated by the United States Federal Reserve Board in its December Bulletin at $3,330,000,000. With fresh credits for war purposes unobtainable except by exports, this sum represents the country's reserve for financing war-time imports. There is thus good reason for husbanding foreign exchange resources, although doubling the present petrol ration would, according to the Motor Trade War Executive, entail only $10,000,000 per annum additional exchange. However, it may attract more cars back to the road, which is not without benefit to the government's domestic revenue. Foreign exchange resources, nevertheless, should not be confused in any way with Britain's internal finances. There is a tendency by some commentators to put the loss of tax potential resulting from motoring depression on the same plane as the exchange question, but actually the two phases of finance are entirely separate.

Internal finance can be adjusted by taxation, including taxes on the country's war production, by loans, or by inflation. Such adjustment may ultimately mean a severe depression of the standard of living, but it has no direct relation to exchange, except in its effect on the nation's ability to export manufactured goods. Under current conditions of complete government control, exchange requirements are determined solely by what is imported and exported. The real question at issue is how far an import surplus, entailing exchange outgoings, can be permitted merely with a view to stimulating internal business activity and thus increasing the nation's taxable capacity.

By purchasing large quantities of domestic engineering equipment and other supplies annually for its overseas operations, the oil industry already greatly helps Britain's export trade in a valuable way. Doubtless this trade could be considerably augmented by manufacturers paying greater attention to the important technical requirements of petroleum production and refinings; by the government giving aid in sterling where a price factor favors the equipment of other countries; by the industry itself taking steps to purchase more British equipment, and by the Ministry of Supply ensuring that priority of materials be freely given to manufacturers and that every possible motion be made to eliminate loss of time through routine procedure and other red tape. The foregoing obviously would do much to ease the sterling-dollar exchange position when further petroleum purchases have to be made.

Up to the present the authorities have intimated that restriction of imports is a major consideration. Limitation of petroleum imports is certainly not the only curb placed on purchases abroad, but it has fallen heavily on motor transport and allied businesses of all kinds.

Expansion of exports appears an obvious alternative to restricting imports of everything but sheer necessities, and the government has turned its attention seriously to the stimulation of Britain's general export trade. But, unfortunately, even a big increase in export business would not necessarily mean a relaxation of restrictions on motoring, unless the oil industry plays a prominent part in increasing exports. Additions to the country's foreign exchange holding otherwise might conceivably be applied to further increases in imports considered vitally necessary for the prosecution of the war.

The war is likely to become intensive at any time, and may be prolonged. It may still make an enormous draft on Britain's reserves of exchange, gold and securities, and the authorities, the only people in possession of the full facts, are evidently and wisely playing for safety and must make the decisions. In setting out to cut motoring so drastically, they have aimed at turning the national energy into war channels as well as restricting import requirements. Time alone will show whether the resulting gains to the war effort justify the undoubtedly heavy losses this policy has involved in the internal financial and industrial sphere. This is the government's responsibility. When all factors have been carefully weighed it is possible that the authorities may find it feasible to modify their restrictions in the interests of the country's revenue and of business in general. Were the oil industry to return to the chaotic state of a few years ago, it must have unfavorable repercussions throughout the world.

# International News and Reports

### Oil Co. Supplier Now Maps Finland for Relief Fund

OTTO G. LINDBERG, one of the largest suppliers of road maps to the oil industry and a leading Finnish-American citizen, has just published a detailed pocket map of Finland in four colors with text and illustrations covering facts about Finland.

This map has been produced entirely free of charge through the cooperation of the printer, typesetter, paper, and ink suppliers who have contributed all labor and materials without cost as a token of their sympathy for Finland.

The new map is now on sale at 50 cents a copy at Finnish Relief headquarters throughout the United States and all proceeds will be turned over to the Finnish Relief Fund, Inc., of which Herbert Hoover is national president.

Copies may also be obtained by mail from the publisher by adding five cents to cover cost of mailing. Address, 21 West Street, New York.

### Exploration In Spain

IN October last a decree was issued introducing new legislation governing the drilling for and production of petroleum in Spain. Under the terms of this decree several concessions have been granted to individuals and firms for surveys and exploratory drilling in various parts of the country. The most important of these appears to be one issued in late January to Mr. H. J. Pierce who is at the head of the Anglo Portuguese Oil Company now engaged in preliminary exploration in Portugal. One of the requirements of the concession is that any oil produced must be delivered to Campsa, the Spanish monopoly, with which Mr. Pierce is reported to have entered into a tentative agreement.

As a result of the prevailing shortage of shipping Campsa and its refining associates, Cepsa, are meeting difficulty in finding tanker tonnage to meet their requirements. Unless the shortage is relieved it may be necessary to institute the rationing of gasoline from April 1. Meanwhile work is being resumed on three tankers building to the order of Campsa, while Cepsa is considering the placing of contracts for two tankers to be built in Spanish yards.

IT IS reported from La Paz that if the Bolivian government is successful in obtaining a proposed loan from the Export and Import Bank, Washington, that it will expend 73,000,000 bolivianos, about $2,000,000 in the purchase of drilling and refinery equipment from the United States. The objective is to increase production from the San Andita field and to enlarge the small refinery located there. These are among the properties seized from the Standard Oil Company of Bolivia by the Bolivian government two years ago.

MORRIS SMITH, son of Walter G. L. Smith, President of E. M. Smith Company of Los Angeles, California, will transfer his activities to the export department of the concern in the near future when he leaves on a business trip of several months' duration to various oil districts throughout South America. Mr. Smith will make the trip to and from the southern continent via Pan-American Airways. His plans include personal contacts with oil company executives and field men in practically every active oil field of Colombia, Peru, Argentina, Brazil, Trinidad and Venezuela. He expects to return to the states about mid-summer.

R. J. W. SMITH was recently appointed Works Manager of Ardrossan (Scotland) Shell Refineries.

# Geology And Economic Significance Of
# MISSISSIPPI OIL DEVELOPMENT

**With Special Reference to the Tinsley Oil Field.**

**By Joseph A. Kornfeld,**
Geologist, Wichita, Kansas

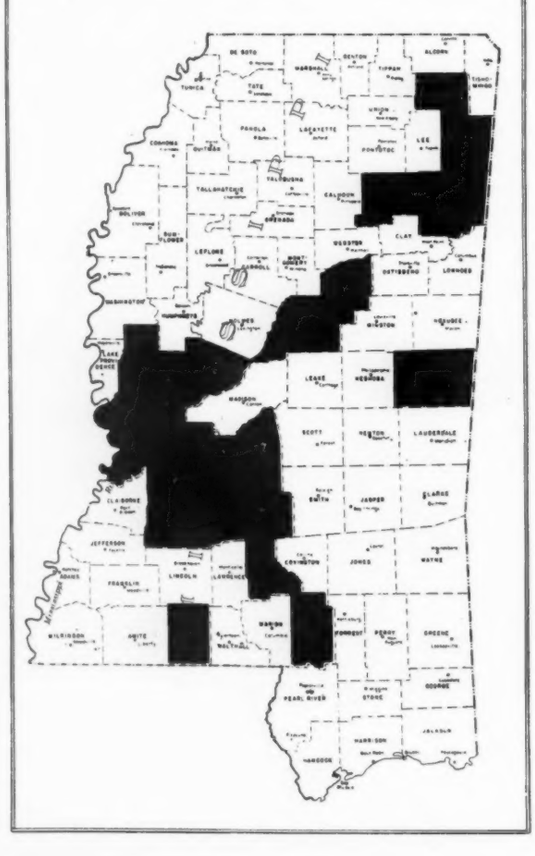
DISCOVERY of commercial oil production at a rank wildcat test in west central Mississippi during the late summer of 1939 resulted in one of the most widespread leasing programs, the southeastern states have ever experienced, revived wildcat drilling on a large scale in the state's many sub-provinces, and developed a new shallow source of high-gravity crude supplies near tidewater.

The Tinsley field, as the new area has been named, lies two miles south of the village of Tinsley in Yazoo county in the west-central portion of the state. The nearest developed oil production lies 44 miles northwestward in the Urbana oilfield in Union county, Arkansas. Nearest Louisiana oil production is in the old Urania pool of LaSalle parish 48 miles southwestward, producing from the Cane River formation of lower Eocene. It is 185 miles from tidewater; being on the Yazoo river, it is only 33 miles from the Mississippi river.

In itself, the Tinsley field has not been spectacular, although at the time of this writing, it has 11 oil wells on 1,200 proven acres on production with a combined daily output of 2,100 bbl., restricted by market outlet to an average of about 300 bbl. per well per day. However, the economic significance lies in the fact that flowing production has been uncovered at comparatively shallow drilling depths in a rank wildcat sector near the coast.

Moreover, it has served as the greatest impetus in coastal history in intensifying leasing and exploration in Mississippi, Alabama, Georgia and Florida.

Major companies early recognized the importance of the new strike and within a few weeks geophysical crews had been shifted from semi-active exploration to the new Mississippi oil mecca. In less than three months from the discovery on August 30, 1939, as many as 53 geophysical crews were working the more promising prospects throughout the state, although it has been the locale of a consistent volume of exploration since 1937, when the discovery of a shallow interior salt dome at Midway in Lamar county brought 20 crews into the state that year.



*Map showing locale of wildcat drilling exploration in Mississippi accelerated by the new Tinsley oil discovery in Yazoo county. (Base map, courtesy National Oil Scouts Association of America.)*

## HISTORY

Semi-commercial oil production had been encountered at Jackson and South Jackson fields in west-central Mississippi since 1930, but the Tinsley field marked the first wildcat pool discovery. The first well to show oil in appreciable amounts on the Jackson structure was encountered in Rankin county by Gulf Oi Corporation's No. 1 A. Rainey in section 13-5n-1e; this well carried oil, gas and salt water in the top of the Selma chalk when tested from 2,500 to 2,520 ft. on March 16, 1930. However, operators were unable to complete the test as an oil well; the well was drilled deeper to a total depth of 3,607 ft. in igneous material and plugged back and completed for a gas well; fuel was obtained from the well for drilling operations in the field, but a short time later the well was abandoned. Later two wells were successfully completed on the northwest flank of the structure from the Selma chalk formation; during 1937, 2,000 bbl. of oil were produced from the wells, but the cumulative production up to November 1, 1939 was only 15,144 bbl. of 19 gravity oil; since then the wells have been abandoned.

A minor oil discovery was recorded on the southeast flank of the Jackson structure: it was Henslee and associates No. 1 Warner in Rankin county which tested an estimated 500 bbl. of 13.6 gravity oil from a total depth of 2,470 ft. in the Selma chalk formation; however, the well was shut in on completion.

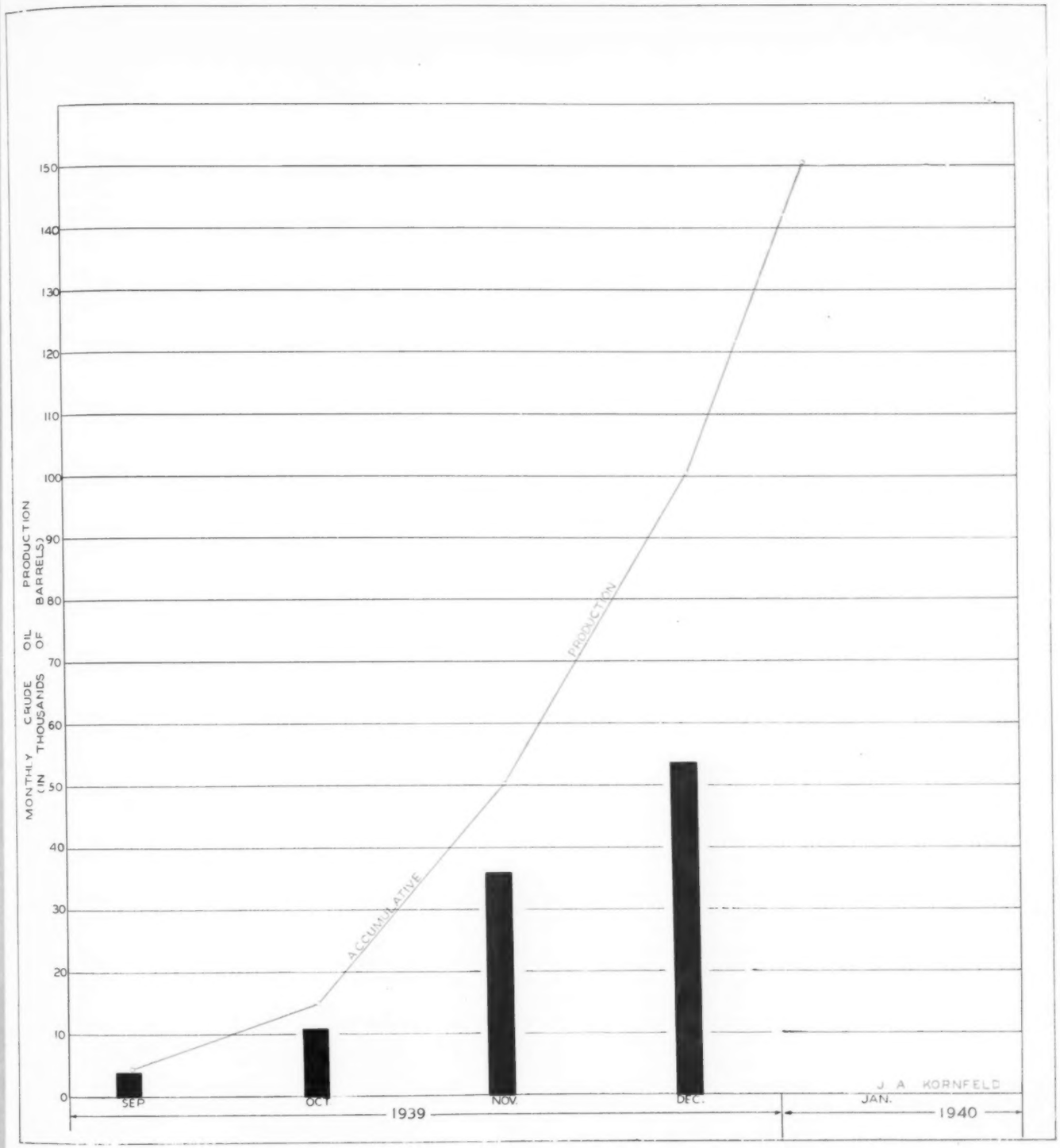
During 1932, considerable interest was created by a rank wildcat test drilled near Quitman in Clarke county in the southeast corner of the state after recovery of cores from the Eutaw sand formation, saturated with dead oil. It was recorded at Gulf Oil Corporation's No. "A"-1 Long Bell Lumber company in the southwest corner of section 10-2n-16e near the Alabama state boundary line. Core cut from 3,692 to 3,700 ft. was described by E. B. Hutson, paleontologist with the Standard Oil Company of Louisiana as "sand-dark-brown from oil, soft, coarse, medium, and fine-grained silty, non-calcareous, glauconitic, petroliferous; age- Eutaw lithology." Hutson reported that "the small fragments of this core which were examined, show a sand that is not very porous, however, it is saturated with dead oil. The well was carried ahead and after reaching a total depth of 4,775 ft. was abandoned. A second test on this structure was a failure at Gulf Oil Corporation's No. 1 Box et al in section 11-2n-15e, five miles west of the first test; it found salt water in drilling to 4,514 ft."

## TINSLEY

Tinsley oil field of Yazoo county, since its discovery on August 29, 1939 has been consistent. Commercial production has been proven in the Woodruff sand of the Selma chalk of upper Cretaceous age in sections 13 and 24 in township 10n-3w, and in the Eutaw sand below the Selma formation in section 12 and 13 of the same township.

The discovery well of the Tinsley pool was Union Producing Company, Houston, Tex., No. 1 G. C. Woodruff, located 660 ft. west of the east line and 1,320 ft. north of the south line out of the southwest corner of section 13-10n-3w. First indications of production were obtained in the initial drill-stem test on August 29 which recovered mud, heavily cut with oil. The test was made from 4,429 to 4,469 ft. in a sandy phase of the Selma chalk. A second drill-stem test was taken from 4,540 to 4,560 ft. in true sand and the the recovery showed 42 stands of 34.9 gravity oil, amounting to 4,200 ft. after the drill pipe was broken out; the testing tool was open for 15 minutes, developing a pressure of only 17 lbs., using quarter-inch chokes, top and bottom. (This was designated the Woodruff pay). It was completed for 312 bbl. of oil in 24 hours through 12/64 in. choke.

A deeper producing horizon for the field was discovered two months later on October 23 one-half mile due north of the original discovery well, at Union Producing Company's No. 1 Jennie Stevens, in the center northwest of section 13-10n-3w. The well recovered 2,900 ft. of 32.8 Baumé gravity oil after developing 20 lbs. pressure during a ten-minute drill-stem test through 3/8 in. chokes from 4,865 to 4,875 ft.; the well was drilled to a total depth of 6,112 ft. in the Tuscaloosa




*Blue columns show monthly production and red line indicates accumulative production of the Tinsley field in Mississippi.*

sand (basal formation of the upper Gulfian Cretaceous) testing salt water when formation tester was run on Tuscaloosa section which originally showed oil; the well was plugged back, casing set through the Eutaw and completed through pipe perforations. It flowed 21 bbl. of oil hourly from 4,867 to 4,877 ft.

Productive limits of the field have been determined on the west, northwest and northeast flanks of the field. The first of the defining tests on the west side was Union Producing Company's No. 1 J. A. Friley, located in the approximate center northwest southeast of section 14-10n-3w, one-half mile due west of the discovery well, which missed the Woodruff sand and cored black shale in the Eutaw formation. It was carried to a total depth of 5,090 ft. Two miles northwest of existing production, T. B. Slick, Jr., No. 1, W. S. Atkinson, was drilled to a total depth of 5,044 ft. in igneous rock after finding no showings in Selma chalk topped at 4,562 ft. and in Eutaw sand section topped at 4,638 ft.; it found formations more than 200 ft. lower than in the discovery well.

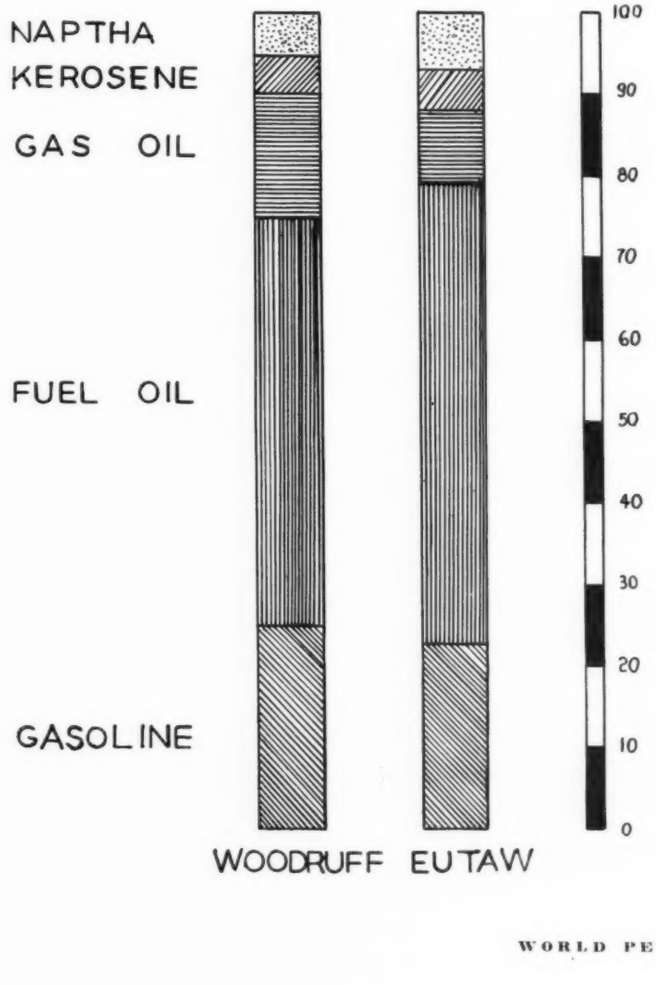
Production was limited on the northeast, one-half mile from production by Plains Production Company's No. 1 Milner, in the approximate center southwest of section 7-10n-2w, after finding the Selma chalk at 4,780 ft., more than 350 ft. structurally low; it was bottomed at a depth of 5,369 ft., after testing 28 stands of oil cut with about one-third salt water on drill-stem test from 4,860 to 4,970 ft.

Sand conditions show a wide range in thickness for the Woodruff sand ranging from zero on the west side of the field to as much as 24 ft. at Union's No. 3 G. C. Woodruff, in the center northwest southeast of section 13-10n-3w, thickening to the northeast; it grades through sandy chalk into chalk upwards. Eutaw sand likewise, thickens to the northeast, as much as 20 ft., having been encountered at Jones & O'Brien, Inc., No. "B"-1, Jennie Stevens, in the center southwest of section 12-10n-3w, below 4,840 ft.

Reservoir conditions show no free gas in the reservoir of the Woodruff or Eutaw sands as far as is known from present development. The oil produced from the Woodruff tests 34.9 deg. Baumé (34.3 deg. A. P. I. gravity) and has a dark-brown color. Eutaw sand crude tests 32.8 degrees Baumé gravity, is of an asphalt base and has a dark-brown color. Bottom hole pressures in the Woodruff sand measure 2,400 lbs. at 4,560 ft.

Structure of the field, mapped on top of the Selma chalk, reveals a south-plunging anticline featured by sharp dips on the northeast, northwest and west flanks. Productive relief exceeds 174 ft. comparing a subsea datum of 4,169 ft. at Union's No. 1 Jennie Stevens, in the center northwest northwest of section 13-, as against a subsea datum of 4,343 ft. at

*Above, Tinsley's daily average production and total number of wells, and below, percentage yields of principal products from crude oil from the Tinsley field, showing comparisons of the Woodruff (discovery) sand of the Selma chalk formation and the Eutaw sand, a deeper pay.*



Union's No. 4 G. C. Woodruff in the center northeast southeast of section 13. The structural axis courses along a south-south-easterly direction. Known evidence points toward a truncated structure of igneous origin of the same type at Jackson in Hinds and Rankin counties.

Casing programs follow a generally uniform schedule. Surface conductor of 16 or 13⅜ in. material is set at about 100 ft. A string of 10¾ in. surface casing is landed at an average depth of 1,470 ft. No additional casing is run until the Woodruff or Eutaw sands are reached. Four cores are required to test these pays properly. Drill-stem tests are run after coring is completed and these are followed by a Schlumberger electrical survey to check coring operations. Unless the test is carried to the Tuscaloosa or deeper formations, field practice dictates the setting of the 7-in. casing at 4,538 ft. for the Woodruff sand or at 4,640 ft. for the Eutaw sand, using 350 sacks of cement. Wells taken to deeper zones for exploratory purposes are plugged back and completed through casing perforations; as many as 240 shots were used to complete Union's No. 2 Jennie Stevens test in the center northeast northwest of section 13, from the Woodruff sand.

Drillings derricks used in the field comprise both the 122-ft. and 136-ft. steel construction, with or without substructures. Heavy-duty equipment predominates at Tinsley; already six steam rigs and two Diesel-powered units are in use. Steam-powered rigs require three 125-h.p. boilers, and two 18-in. or 20-in. slush pumps. Formations drill fairly easy and drilling time averages 22 days from the surface to the Woodruff sand. Six rock bits and two fishtail bits are sufficient to drill the well to the field pays. For precautionary measures, contractors install blowout preventers on the surface casing.

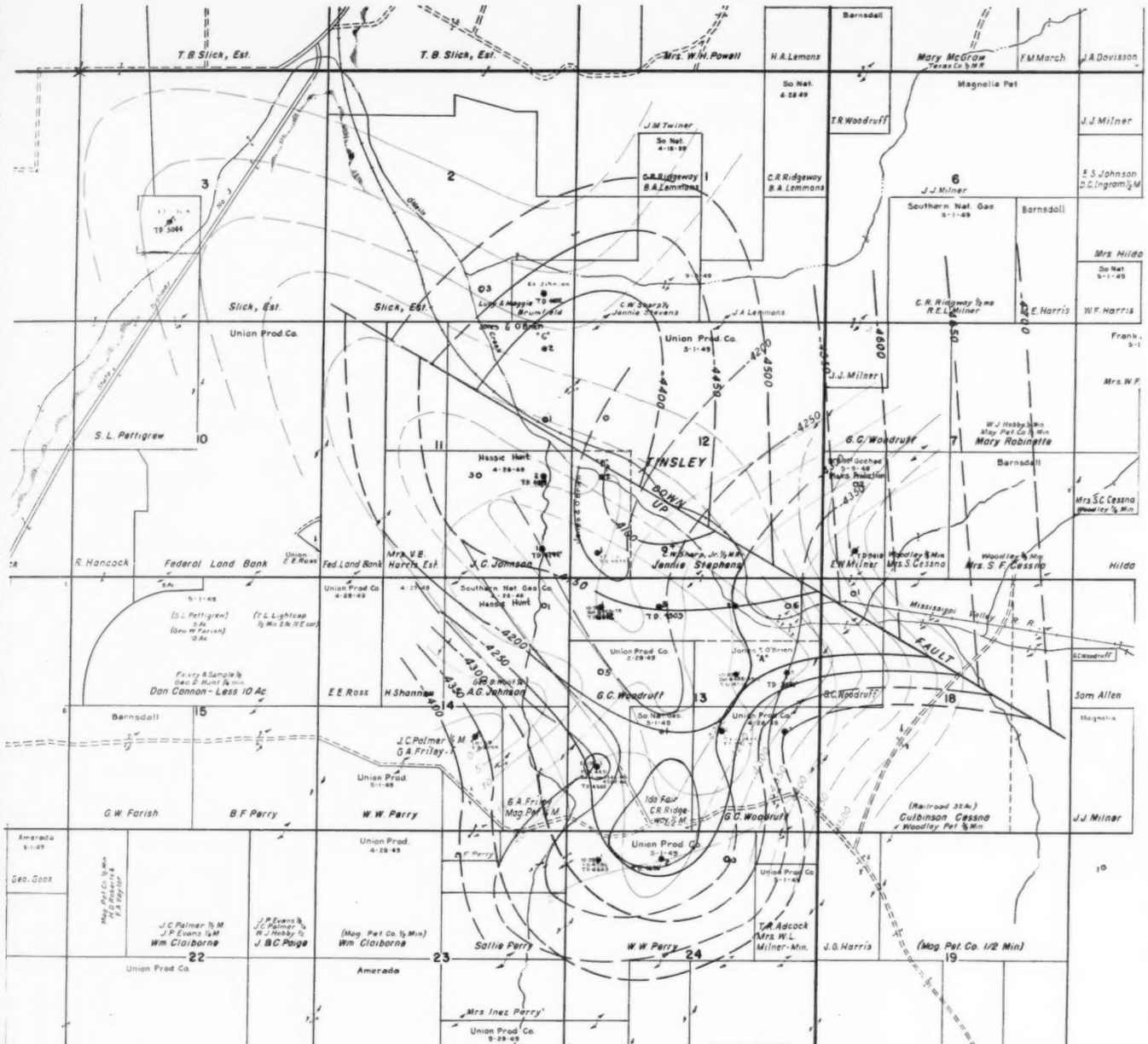
Completion methods involve washing the well into production through tubing as general practice; if this fails (due to the low formation pressures), the wall is swabbed through the tubing.

Type section of the Tinsley field is represented by the log of the discovery well—Union's No. 1 G. C. Woodruff, in the center of the west half of the southwest quarter of section 13. (elev. 174.87 ft.).

| | Top | | Base | Thickness plus |
|---|---|---|---|---|
| **TERTIARY—** | | | | |
| **Eocene:** | | | | |
| Jackson | 0 | to | 57 | 57 |
| Claiborne | 57 | to | 1,640 | 1,583 |
| Wilcox formation (unconformity) | 1,640 | to | 3,567 | 1,927 |
| Midway formation (unconformity) | 3,567 | to | 4,429 | 862 |
| **MESOZOIC—** | | | | |
| **Cretaceous—Gulfian Series** | | | | |
| Selma chalk | 4,429 | to | 4,550 | |
| Woodruff sand | 4,550 | to | 4,560 | in sand |

Tuscaloosa sand possibilities for the field were unfavorably tested near the crest of the structure (as now known) by Union No. 1 Jennie Stevens, in the center northwest of section 13-10n-3w. Operators cored from 5,407 to 5,417 ft. recovering streaks of oil sand and shale followed by five feet of red, greenish gray shale. A drill-stem test was run early in November from 5,407 to 5,417 ft. using ⅜ in. chokes, top and bottom, after the testing tool was opened for seven minutes, recovery showed only 290 ft. of mud; three other drill-stem tests near this level were missed. The well was taken deeper and alternatedly cored and drilled to 5,508 ft. A drill-stem test was run to test sand logged with an oil showing from 5,492 to 5,508 ft., but

*Outline map Mississippi and surrounding areas showing regional structural features in red and oil and gas production in blue: note location of Tinsley oil field and Jackson and Armory gas fields discussed in this article.*




*Detailed map of Tinsley oilfield, Yazoo County, Mississippi: Blue lines indicate structural contours on top of Woodruff sand; orange lines show thickness of Woodruff; red lines indicate structural contours on top of Selma chalk.*

recovery was only 3,900 ft. of salt water after testing tools was open 13 minutes. After being drilled to 6,100 ft., the well was plugged back and gun-perforated opposite the Eutaw sand for completion. A similar experience has been recorded for the Tuscaloosa sand horizon in the old Jackson field.

Wildcat drilling is in progress in 18 counties confined principally to the northeastern, west-central and southwestern sectors of Mississippi. Operations are listed for the following counties: Attala, Chicasaw, Choctaw, Copiah, Hinds, Itawanba, Issaquena, Jefferson Davis, Kemper, Lamar, Monroe, Pike, Prentiss, Rankin, Sharkey, Simpson, Warren and Yazoo.

**Detailed Well Data, Tinsley Oil Field, Yazoo County, Mississippi**

| Operator | Lease and Well | Total Depth | Status | Top of Selma | Geologic Woodruff | Marker Eutaw |
|---|---|---|---|---|---|---|
| UNION PROD. | Woodruff 1 | 4560 | OILER | 4429 | 4540 | .... |
| | Woodruff 2 | 4578 | OILER | .... | 4538 | .... |
| | Woodruff 3 | 4596 | OILER | 4454 | 4570 | .... |
| | Woodruff 4 | .... | OILER | 4579 | .... | 4700 |
| | J. Stevens 1 | 6112[2] | OILER[1] | 4395 | .... | .... |
| | J. Stevens 2 | 4561 | OILER | .... | 4504 | .... |
| | J. Stevens 3 | .... | DRLG. | .... | .... | .... |
| | J. Stevens 4 | .... | DRLG. | .... | .... | .... |
| | W. W. Perry 1 | 4603 | OILER | 4485 | 4586 | .... |
| | W. W. Perry 2 | .... | OILER | .... | .... | .... |
| | G. A. Friely 1 | 5090 | D. & A. | .... | .... | .... |
| JONES-O'BRIEN | J. Stevens A1 | 4519 | OILER | 4400 | 4488 | .... |
| | J. Stevens A2 | 5080 | OILER | 4445 | 4560 | .... |
| | J. Stevens B1 | 4895 | OILER[1] | .... | .... | .... |
| | J. Stevens B2 | 6134[2] | OILER | .... | 4396 | .... |
| | J. Stevens C1 | .... | DRLG. | .... | .... | .... |
| | J. Stevens C2 | .... | DRLG. | .... | .... | .... |
| HASSIE HUNT | J. C. Johnson 1 | 4792 | OILER[1] | .... | .... | 4773 |
| | J. C. Johnson 2 | 4812 | OILER[1] | .... | .... | 4788 |
| | Ida Fair 1 | .... | DRLG. | .... | .... | .... |
| E. C. JOHNSON | Broomfield 1 | 4832 | OILER | 4655 | 4810 | .... |
| T. B. SLICK, JR. | W. Atkinson 1 | 5088 | DRY & A. | 4562 | .... | 4638 |
| PLAINS PROD. | Milner 1 | 5418 | OILER | 4710 | .... | .... |
| | Milner 2 | .... | LCN. | .... | .... | .... |
| J. R. LOCKHART | F. Brooks 1 | .... | DRLG. | .... | .... | .... |

[1]Producing from deeper oil zone—Stevens sand of Eutaw formation.
[2]Tested dry in Tuscaloosa sand formation before plugging back.

**Statistics For Tinsley Field—Mississippi**

| | |
|---|---|
| Number of holes drilled (completed or uncompleted) | 14 |
| Average depth of all holes drilled (completed or uncompleted) | 4,625 ft. |
| Number of producing oil wells (January 8, 1940) | 11 |
| Number of producing oil wells in Selma (Woodruff sand) | 8 |
| Number of producing oil wells in Eutaw sand | 3 |
| Deepest hole drilled (Union-1 Stevens, 13-10s-3w) | 6,100 ft. |
| Deepest formation tested | Tuscaloosa |
| Amount of acreage in proved area (approx.) | 1,200 |
| Amount of acreage in proved area: Woodruff sand | 900 |
| Amount of acreage in proved area: Eutaw sand | 300 |
| Length of producing area | 2½ miles |
| Width of producing area | 1 mile |
| Average production of oil per well under present conditions | 300 bbl. |
| Gravity of crude oil: Woodruff sand | 34.9 Be |
| Gravity of crude oil: Eutaw sand | 32.8 Be |
| Initial "closed in" pressure (at casinghead) | 280 lbs. |
| Initial bottom-hole pressure: Woodruff sand | 2,460 lbs. |
| Discovery data of Selma (Woodruff sand) production | Aug. 29, '39 |
| Discovery data of Eutaw sand production | Oct. 23, '39 |
| Location of field—1 mile south of the town of Tinsley in sections 12, 13, 24 in township 10 north, range 3 west, Yazoo county. | |
| Accumulative production (Dec. 14, 1939) | 72,530 bbl. |

## CEMENTING PRACTICE

Casing and cementing practice during the first four months of the Tinsley field development followed the method of setting two joints of 16-in. conductor pipe to 40 to 50 ft., cementing it with 50 sacks and allowing a time lapse of 24 hours before drilling the plug; setting 1,500 ft. of 10¾-in. surface casing, cementing it with from 350 to 528 sacks of fast-setting cement—it would require from 45 minutes to one hour to mix the cement, pump plug to bottom; a time lapse of 48 hours was allowed before crews were ordered to drill out the plug.

During January, the State Oil and Gas Board changed the casing program allowing operators to set only 600 ft. instead of 1,500 ft. of 10¾-in. surface casing; consequently operators are using from 150 to 300 sacks of fast-setting cement under the new casing practice; cement is allowed to set 48 hours before plug is drilled.

The oil string is landed at an average depth of 4,470 ft. on top of the Selma chalk, in case of Woodruff sand completions; at 4,850 ft. in the Eutaw sand, in case of Eutaw completions; with the exception of tests drilled to the Tuscaloosa formation in which case casing is shot with gun-perforator, opposite the Eutaw sand. Cementing practice requires from 300 to 450 sacks of fast-setting cement. From 50 to 60 minutes is required to mix the slurry and pump the plug to bottom. A time lapse of 72 hours is allowed before plug is drilled.

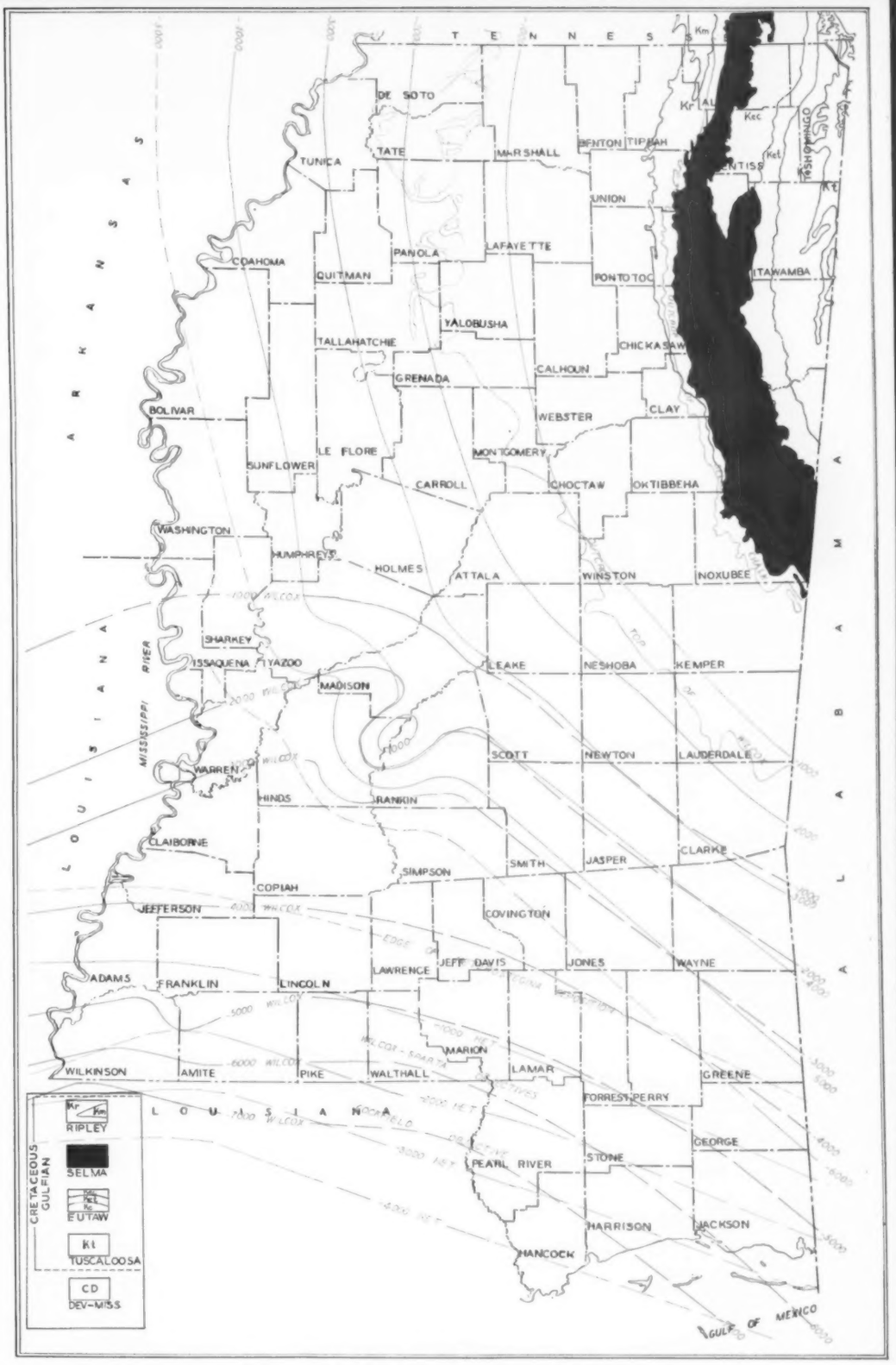
## TINSLEY EXPLORATION

Original surface structure survey of the Tinsley dome was prepared by Frederick F. Mellen, cooperating with the Mississippi State Geological Survey in a minerals survey of Yazoo county. Mellen worked the area in October, 1938 when he discovered an inlier of Moody's Branch marl of lower Jackson age on Perry Creek where normally younger Yazoo clays of upper Jackson age should have been found. Checking the base of the Moodys Branch marl, Mellen mapped a surface closure of at least 135 ft. using barometric readings; and substantiating his work by mapping the structure of the higher bentonite beds.

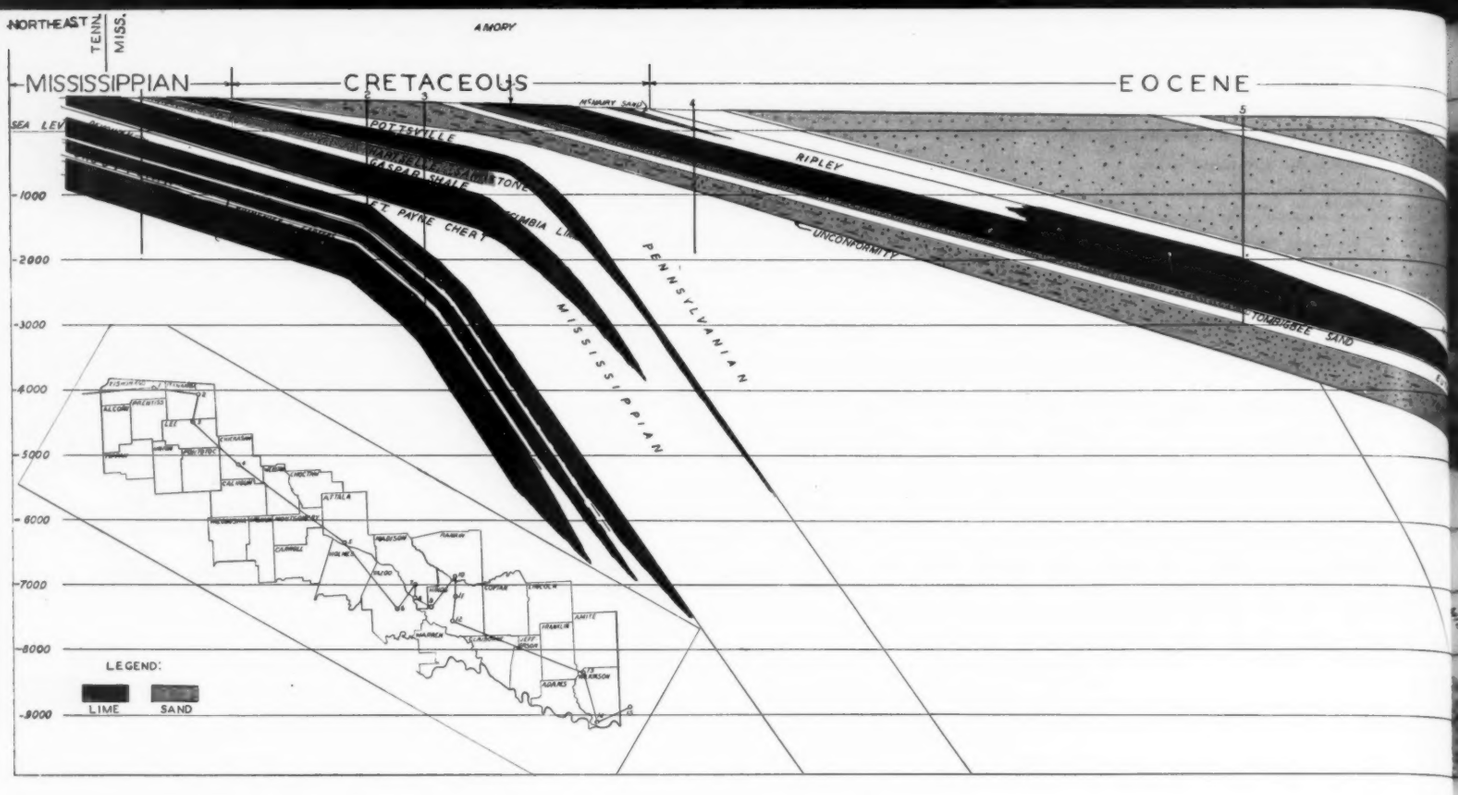
Results of Mellen's field work were published in a memorandum for the press released by William G. Morse, state geologist, for the Mississippi State Geological Survey, on April 12, 1939. Morse had spent a few days in the field, reviewing Mellen's structural discovery.

The press release attracted the attention of Union Producing Company of Houston, Texas. This firm worked the structure with reflection seismograph, assembled a large block of acreage and drilled their first test at No. 1 G. C. Woodruff, one mile south of the

[1] R. L. Johnson, Yazoo City, Miss., Halliburton Oil Well Cementing Company, personal communication.




*County map of Mississippi showing interior salt dome basin in blue, top of Selma chalk and Heterostegina in orange and top of Wilcox in red.*




**Analysis of Typical Crude Oil from the Tinsley Field**
**A. Woodruff Sand (Selma Formation)**

**UNITED GAS PIPE LINE COMPANY**
**Laboratory Report**
**No. 8016**

**(Date: September 18, 1939)**

**Sample of:** Crude Oil
**From:** Union Producing Company, Woodruff #1
**Location:** Yazoo County, Mississippi.
**Remarks:** 9/64 choke—Sample taken 9-7-39.
Casing Pressure: 385#
Tubing Pressure: 345#
Separator Pressure: 20#

**ANALYSIS**

Gravity ..... 34.9 Be
Color ..... Dark Brown

| % Over | Vapor Temperature | Be° Fraction | Be° Total Over |
|---|---|---|---|
| I. B. P. | 127 | .... | .... |
| 10 | 275 | 76.9 | .... |
| 20 | 370 | 61.2 | 68.1 |
| 25 | 426 | 51.7 | 64.4 |
| 30 | 478 | 47.5 | 47.5 |
| 35 | 530 | 43.4 | 43.4 |
| 45 | 602 | 38.6 | .... |
| 50 | 622 | 36.1 | 37.9 |
| Bottoms | | | 20.5 |

**Summary**

| | |
|---|---|
| Gasoline 25% | Gravity 64.4° Be A. P. I. |
| Naphtha 5% | Gravity 47.5° Be A. P. I. |
| Kerosene 5% | Gravity 43.4° Be A. P. I. |
| Gas Oil 15% | Gravity 37.9° Be A. P. I. |
| Fuel Oil 50% | Gravity 20.5° Be A. P. I. |

village of Tinsley. It encountered saturation 56 ft. in Selma chalk topped at 4,394 ft.; with the Woodruff discovery pay topped at 4,375 ft. subsea datum. An extremely thin section of Selma chalk is recorded at Tinsley, while 15 miles to the southeast, 930 ft. of Selma chalk section was encountered at Union Producing Company's No. "A"-1 Anderson, which topped Selma chalk at 4,350 ft. and based that formation at 5,280 ft.; it was drilled to a total depth of 6,228 ft. The thin interval at Tinsley is reflected in a 76-ft. thickness of the Selma formation recorded on the northeast flank of the structure at T. B. Slick, Jr., No. 1 W. S. Atkinson, which topped the Selma chalk at 4,562 ft. and based it at 4,638 ft., the top of the Eutaw. However, even thinner intervals will be observed on the crest of structure shown in the regional isopachous map of the Selma formation reproduced elsewhere in this article.

## MARKET OUTLET

Principal purchaser of crude oil in the Tinsley field since its discovery was Standard Oil Company of Louisiana, which announced it would discontinue purchases of crude on December 31, 1939; but after a revision of railroad rates agreed to continue 30 days longer. The production was moved by rail from a loading rack near the field to Baton Rouge, where their principal refinery is located. Standard has been buying an average daily take of 300 bbl. per well; for the week

**Analysis of Typical Crude Oil from the Tinsley Field B. Eutaw Sand**

**UNITED GAS PIPE LINE COMPANY**
**Laboratory Report**
**#8143**

**(Date: October 27, 1939)**

**Sample:** Crude Oil
**From:** Union Producing Company's, Stevens #1
**Location:** Section 13-10N-3W, Yazoo Co., Mississippi.
**Remarks:** D. S. T. 4865-75'—Sample takes 10-23-39.

**Analysis:**

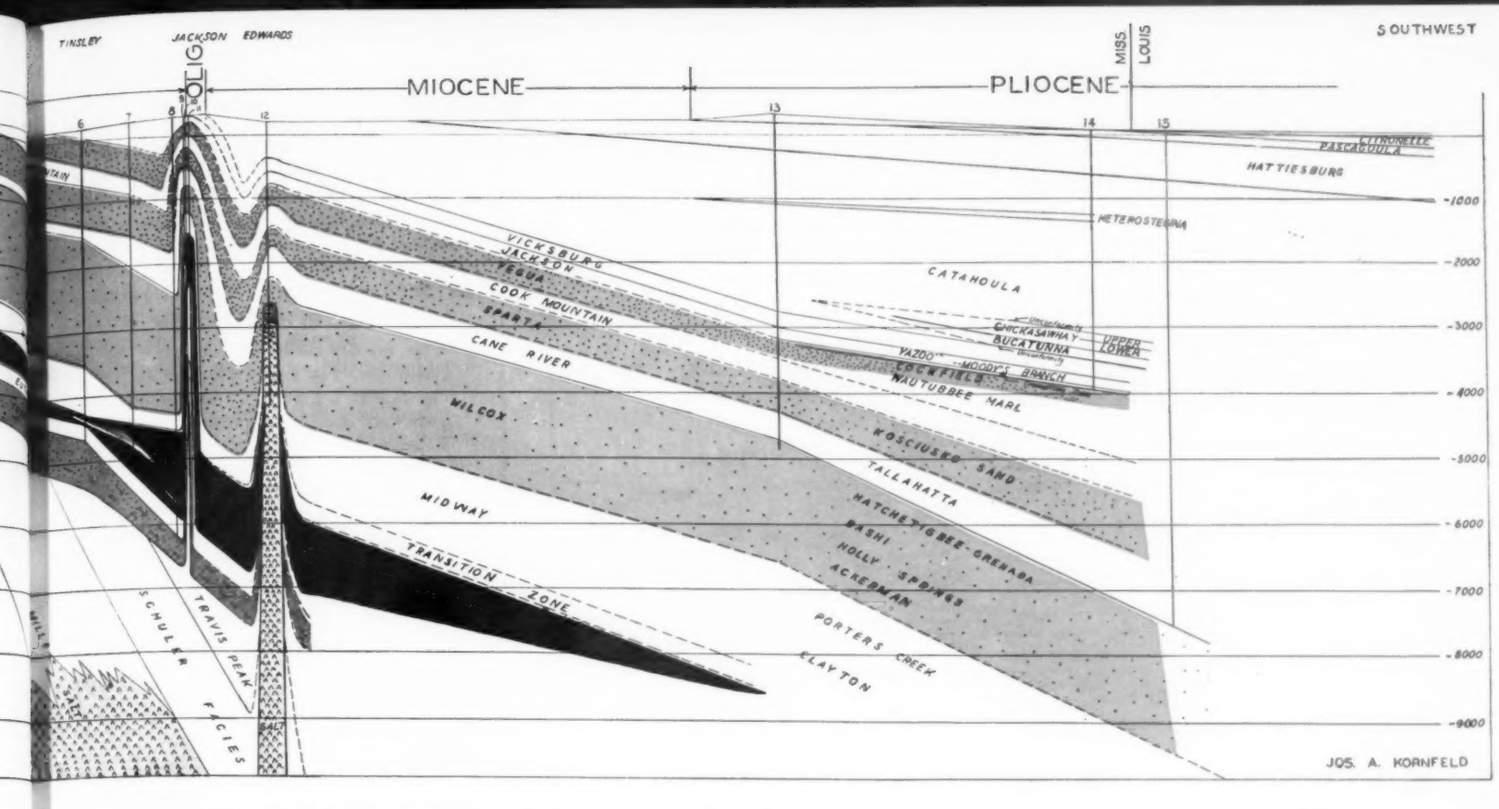
Gravity ..... 32.8° Be
Color ..... Dark Brown
Asphalt Base

| % Over | Vapor Temp. | Oil Temp. | Be° Fraction | Be° Total Over |
|---|---|---|---|---|
| I. B. P. | .... | 214 | .... | .... |
| 5 | 226 | 332 | 79.0 | .... |
| 10 | 274 | 390 | 69.5 | 73.4 |
| 15 | 328 | 446 | 61.7 | 69.3 |
| 20 | 378 | 500 | 56.1 | 65.5 |
| 22.5 | 400 | 525 | 52.6 | 63.8 |
| 27.5 | 452 | 578 | 49.5 | .... |
| 30 | 480 | .... | 46.4 | 48.5 |
| 35 | 532 | .... | 43.4 | 43.4 |
| 40 | 580 | 698 | 40.3 | .... |
| 44 | 598 | 725 | 37.4 | 39.2 |
| Bottoms | | | | 19.8 |

**Summary**

| | |
|---|---|
| Gasoline 22.5% | Gravity 63.8 °Be A. P. I. |
| Naphtha 7.5% | Gravity 48.5 °Be A. P. I. |
| Kerosene 5.0% | Gravity 43.4 °Be A. P. I. |
| Gas oil 9.0% | Gravity 39.2 °Be A. P. I. |
| Fuel Oil 56.0% | Gravity 19.8 °Be A. P. I. |

Flash 30°F
Viscosity at 100/66 saybolt seconds
Sulphur 0.89%
Pour Test—Below Zero °F



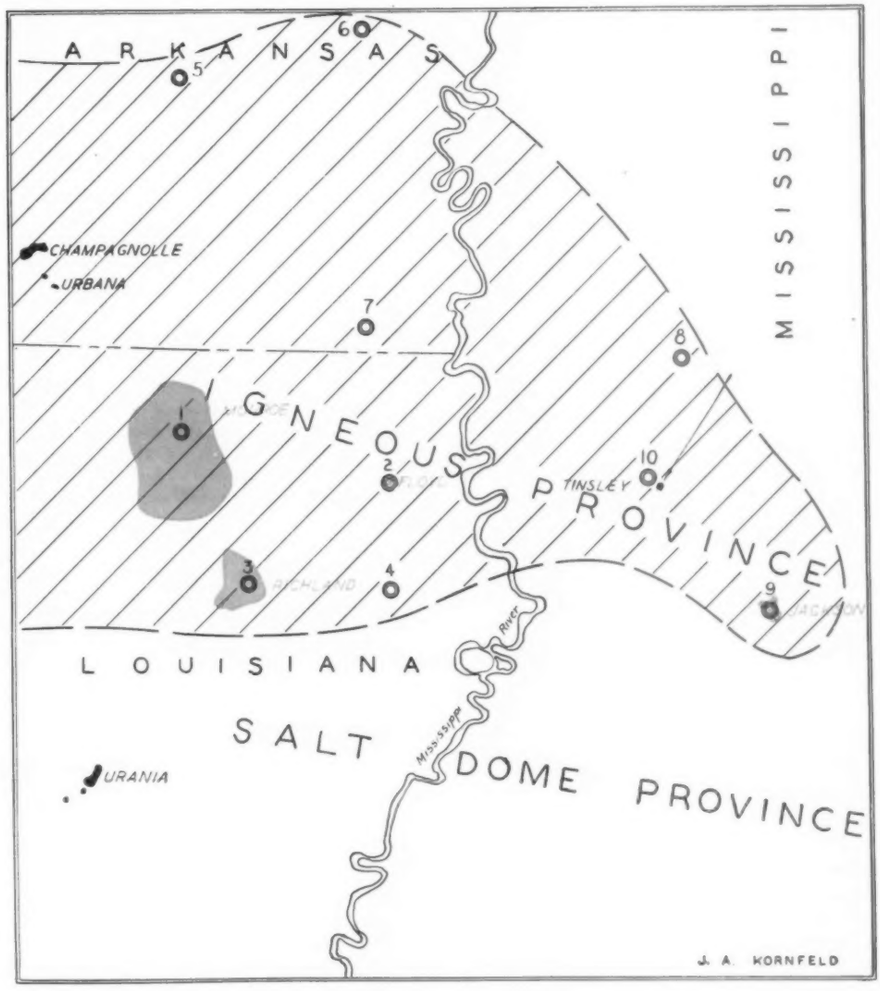

*Above, regional cross-section of Mississippi following the line shown on small inset map at left: lime formations in blue, Cretaceous and older sands in red and Tertiary sands in orange.*

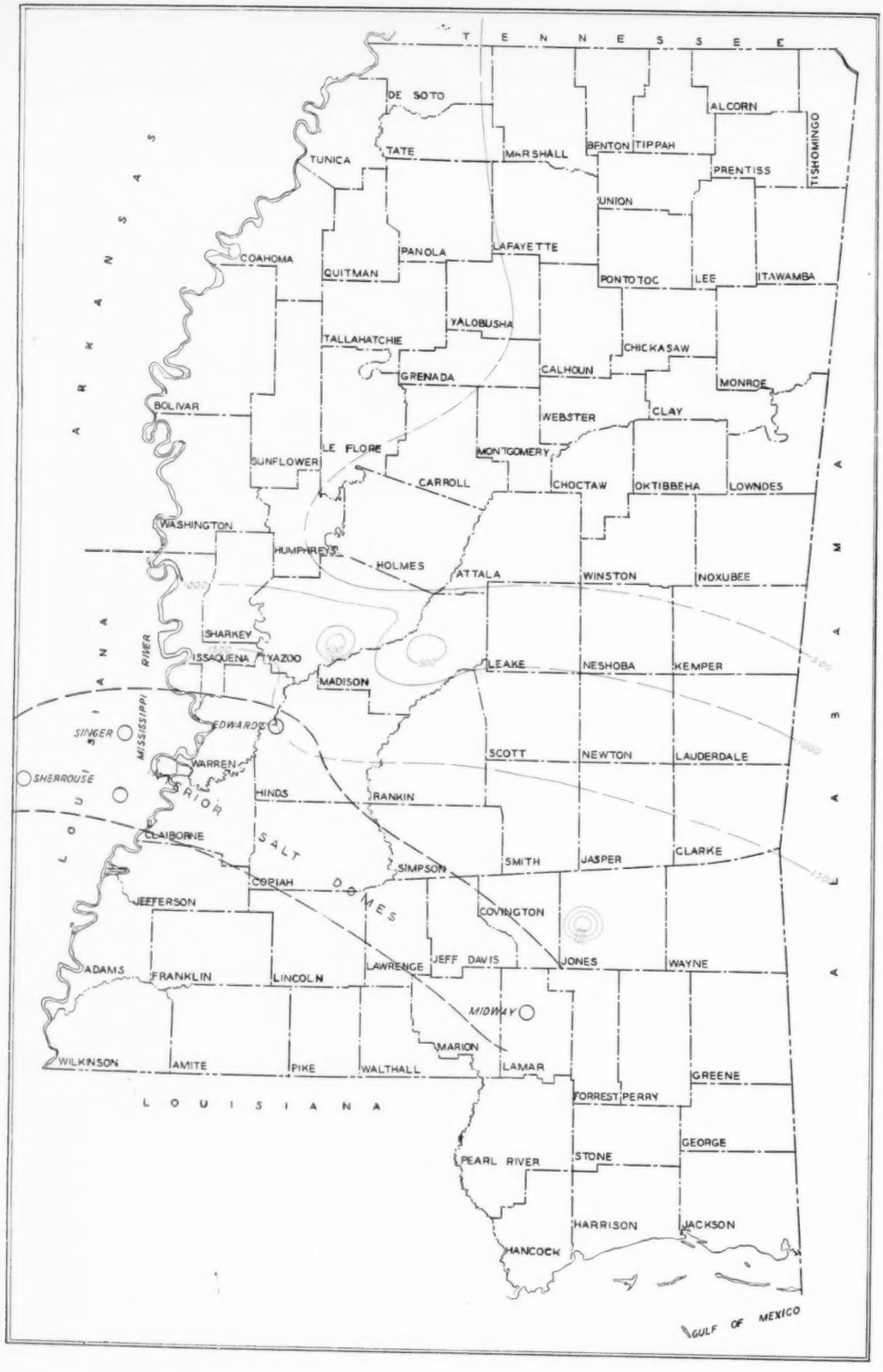
*Below, relation of Tinsley to a province of igneous intrusion.*

## WILDCAT DRILLING STATISTICS

(Development to December 1, 1939)

| County | Number of Tests Completed | Total Footage Tabulation | Deepest Depth of Well | Test Dril'd Deepest Fmtn. Encount'd |
|---|---|---|---|---|
| Adams | 3 | 9,250 | 4,510 | ..... |
| Alcorn | 2 | 4,413 | 2,735 | ..... |
| Amite | 2 | 6,024 | 5,224 | Wilcox |
| Attala | 3 | 6,472 | 3,772 | Tuscaloosa |
| Bolivar | 3 | 10,315 | 6,009 | Paleozoics |
| Calhoun | 6 | 8,847 | 2,120 | ..... |
| Chickasaw | 7 | 8,783 | 2,340 | Paleozoics |
| Claiborne | 9 | 15,969 | 2,220 | ..... |
| Clark | 10 | 23,796 | 4,775 | ..... |
| Clay | 1 | 4,680 | 4,680 | ..... |
| Copiah | 7 | 15,747 | 2,800 | ..... |
| Covington | 9 | 31,594 | 8,002 | Eutaw |
| Forrest | 1 | 3,007 | 3,007 | Claiborne |
| Franklin | 4 | 16,920 | 5,011 | ..... |
| George | 11 | 48,491 | 8,038 | ..... |
| Greene | 2 | 12,880 | 7,439 | ..... |
| Grenada | 4 | 13,635 | 4,600 | Pennsylvanian |
| Hancock | 6 | 19,591 | 4,251 | ..... |
| Hinds | — | — | 8,484 | Cretaceous |
| Holmes | 1 | 2,435 | 2,435 | ..... |
| Humphreys | 3 | 10,666 | 5,652 | ..... |
| Issaquena | 6 | 17,014 | 3,532 | Trinity |
| Jackson | 18 | 49,317 | 5,221 | ..... |
| Jasper | 3 | 11,024 | 5,111 | ..... |
| Jefferson | 2 | 3,775 | 2,575 | ..... |
| Jefferson Davis | 1 | 3,129 | 3,129 | ..... |
| Jones | 5 | 20,528 | 4,863 | ..... |
| Lafayette | 2 | 2,975 | 2,465 | ..... |
| Lauderdale | 12 | 36,780 | 5,111 | ..... |
| Leflore | 2 | 3,902 | 3,502 | ..... |
| Lowndes | 4 | 9,355 | 4,006 | ..... |
| Lamar | 12 | 47,483 | 8,673 | Tuscaloosa |
| Leake | 1 | 3,502 | 3,502 | ..... |
| Lee | 2 | 4,507 | 3,207 | Trenton lime |
| Lincoln | 1 | 2,221 | 2,221 | ..... |
| Madison | 9 | 33,007 | 6,265 | ..... |
| Marion | 1 | 2,606 | 2,606 | ..... |
| Marshall | 3 | 7,644 | 3,248 | ..... |
| Monroe | 14 | 33,059 | 4,093 | ..... |
| Montgomery | 1 | 4,260 | 4,260 | ..... |
| Neshoba | 1 | 1,890 | 1,890 | ..... |
| Newton | 1 | 3,020 | 3,020 | ..... |
| Noxubee | 1 | 1,890 | 1,890 | ..... |
| Oktibbeha | 2 | 2,315 | 1,415 | ..... |
| Panola | 2 | 4,686 | 2,389 | ..... |
| Pike | 3 | 9,927 | 4,028 | ..... |
| Pearl River | 5 | 18,548 | 4,870 | ..... |
| Perry | 4 | 17,587 | 8,434 | ..... |
| Pontotoc | 1 | 310 | 310 | Ripley |
| Rankin | — | — | — | Cretaceous |
| Scott | 1 | 5,272 | 5,272 | Eutaw |
| Sharkey | 2 | 7,257 | 3,807 | ..... |
| Simpson | 5 | 16,098 | 4,360 | ..... |
| Smith | 1 | 5,506 | 3,519 | ..... |
| Sunflower | 4 | 14,516 | 3,801 | ..... |
| Stone | 5 | 22,903 | 7,943 | Eutaw |
| Tallahatchie | 14 | 48,245 | 7,581 | ..... |
| Tishomingo | 2 | 4,112 | 2,210 | Knoxdolomite |
| Union | 1 | 1,500 | 1,500 | ..... |
| Warren | 13 | 34,636 | 5,114 | ..... |
| Washington | 5 | 13,355 | 3,455 | Cretaceous |
| Wayne | 2 | 7,177 | 5,505 | ..... |
| Webster | 1 | 1,962 | 1,962 | ..... |
| Wilkinson | 12 | 49,130 | 5,509 | ..... |
| Winston | 3 | 7,525 | 2,740 | ..... |
| Yalobusha | 8 | 21,222 | 3,510 | Midway |
| Yazoo | — | — | 6,110 | Tuscaloosa |






ending January 13, 1940, it bought 2,650 bbl. daily.

The second market outlet for the field was provided late in January by Hassie Hunt, operator in the north end of the field. He has completed erection of a 10-car loading rack one mile north of Tinsley where 10,000 bbl. of storage facilities have been built. Crude will be moved by rail westward to Vicksburg, thence by barge down the Mississippi river for export shipment.

Hunt has contracted for the output of all production developed by Edgar C. Johnson of Longview, Texas, including the latter's extension producer in the center southeast of Section 2, T. 10 N., R. 3 W, which extended the field one mile northward during January. Hunt has posted a price of 80 cents a barrel.

*Thickness of Selma chalk formation of upper Cretaceous age.*

## GEOPHYSICS

The rapidly-rising concentration of geophysical crews in the Mississippi exploration scene rose to a high of 65 parties in January. These were comprised as follows:

| | |
|---|---|
| Seismograph | 30 crews |
| Gravimeter | 30 crews |
| Magnetometer | 4 crews |
| Millivolt Electrical | 1 crew |

Four additional parties were active in Alabama, at the same time, of which two were seismograph, the others magnetometer.

Of interest is the concentration of four magnetometer crews in the igneous province of western Mississippi seeking anomalies that might be reflected from igneous intrusives; these geophysical parties are working in Washington, Sunflower, Holmes, and adjacent counties.

The rising popularity of the gravimeter method is important to note, and by January 13 had gained in number of crews working to match the number of seismograph parties. Geophysical activity has shown a steady, regular rise since September 7 when only eight crews were active.

## LEASING

Leasing which was reported at 1,500,000 acres in effect at the time of the discovery of the Tinsley field, rose sharply thereafter with an additional 720,000 acres signed up during the past six months. Acreage purchases remained below the 100,000-acre weekly mark until November 10 when buying rose to 350,000 acres for the week. The peak in leasing activity was reached on November 28 when weekly acreage purchases were registered at 560,000 acres; another high week was recorded on December 10 when 415,000 acres were placed under lease.

## IGNEOUS PROVINCE

Geologic evidence from available well records coupled with regional position definitely places the Tinsley dome well within the igneous province occupying portions of western Mississippi, northeastern Louisiana and southeastern Arkansas. Igneous rock was first observed in this province during 1928 on the Richland structure, Louisiana, in Moody-Seagraves' No. 1 Osborne, in S. 14, T. 15n., R. 5 E., from 2,475 to 2,500 ft., which was identified as nepheline basalt. Other wells situated in or adjacent to the Richland field encountered igneous rock intrusive and extrusives at depths ranging from 2,300 to 2,500 ft.[3]

Igneous rock was found in rotary drill cuttings in December, 1939 on the northwest flank of the Tinsley dome in Yazoo county at an outpost situated only 193 ft. structurally lower than the highest structural position recorded in the field known at the date of this writing; it was observed at T. B. Slick,

Jr., No. 1 W. S. Atkinson, in the northwest northeast southwest of section 3., T. 10 N., R. 3 W., in drilling to a total depth of 5,083 ft. in the Tuscaloosa formation; earlier, this well topped the Selma chalk at 4,562 ft., and the Eutaw formation at 4,638 ft. This comparative occurrence of igneous material near the crest of the structure suggests similarity of origin to the Jackson structure.

Additional proof of the existence and locale of the igneous province is reflected by a recent abandonment in Sharkey County. Charles W. Crader encountered igneous rock in drilling to a total depth of 4,015 ft. in the Tuscaloosa formation at his No. 1 D. D. Wells; location is 600 ft. north and 860 ft. west of the southeast southeast northwest quarter of S. 27, T 12, N., R. 7 W., Selma chalk was topped at 3,423 ft.

Igneous rock was encountered 130 ft. below the top of the Cretaceous unconformity, 14 miles southeast of the Richland field, but five miles northeast of Winnsboro in Franklin parish, Louisiana, at Evansville Investment Company's No. 1 Welch, in S. 2., T. 14 N., R. 8 E.; the Cretaceous angular unconformity was topped at 4,140 ft., and igneous rock cored at 4,270 ft.[4]

In the same igneous province, the Jackson structure has been proven the locale of igneous rocks and altered igneous rocks at structural levels ranging from 160 to 300 ft. below the highest structural position in the field.[5] R. Dana Russell, of Louisiana State University, who examined several samples of igneous material from Jackson wells states that they indicate an igneous rock of syenitic composition and of hypabyssal occurrence, judging from the texture.[6]

Considerable diversity in rock types is represented among the igneous rocks younger than pre-Cambrian in the Central Mississippi Valley according to Tolman and Landes.[7] The different igneous bodies younger than the pre-Cambrian in the Central Mississippi Valley have been found in intrusive contact with various horizons in the Paleozoic and Early Cretaceous. These intrusives are younger than Early Cretaceous which they intrude and are not younger than Upper Cretaceous. Upper Cretaceous rocks overlie peridotite of the volcanic pipes of Pike County, and also, horizons of this age contain extensive volcanic fragmental material related to the pipes. Spurr reasons that the Central Mississippi Valley was underlain by a magna which, in late Cretaceous times, gave rise to the intrusive igneous rocks. The author gives considerable credence to this hypothesis.

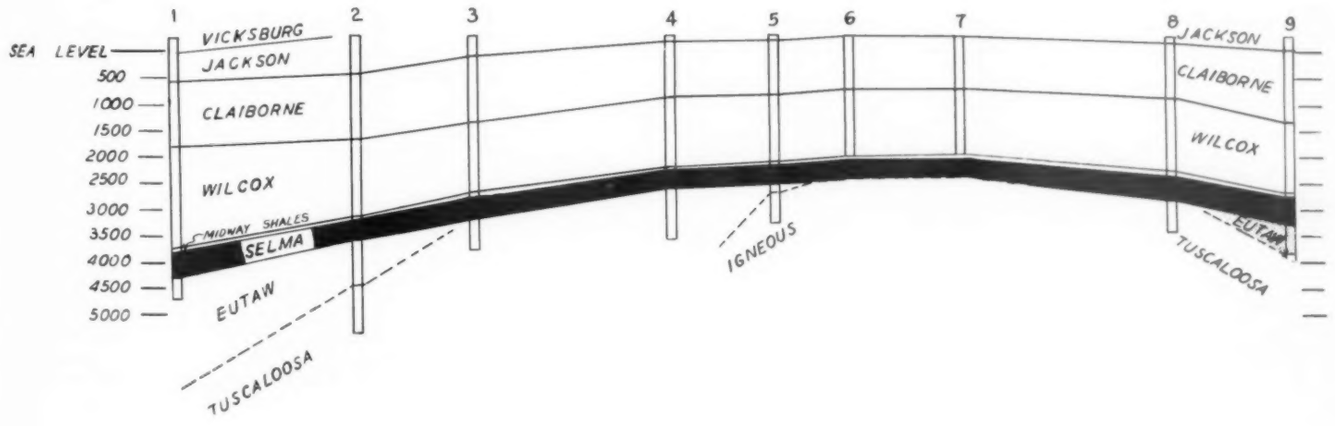
Existence of a Paleozoic period of igneous intrusion in the central Mississippi Valley is furnished by the observation of C. W. Honess in southeastern Oklahoma that a diorite dike intrusive into the Ordovician was severely deformed by the late Paleozoic folding and thrusting of the Ouachita Mountains. The

**COLUMNAR SECTION**

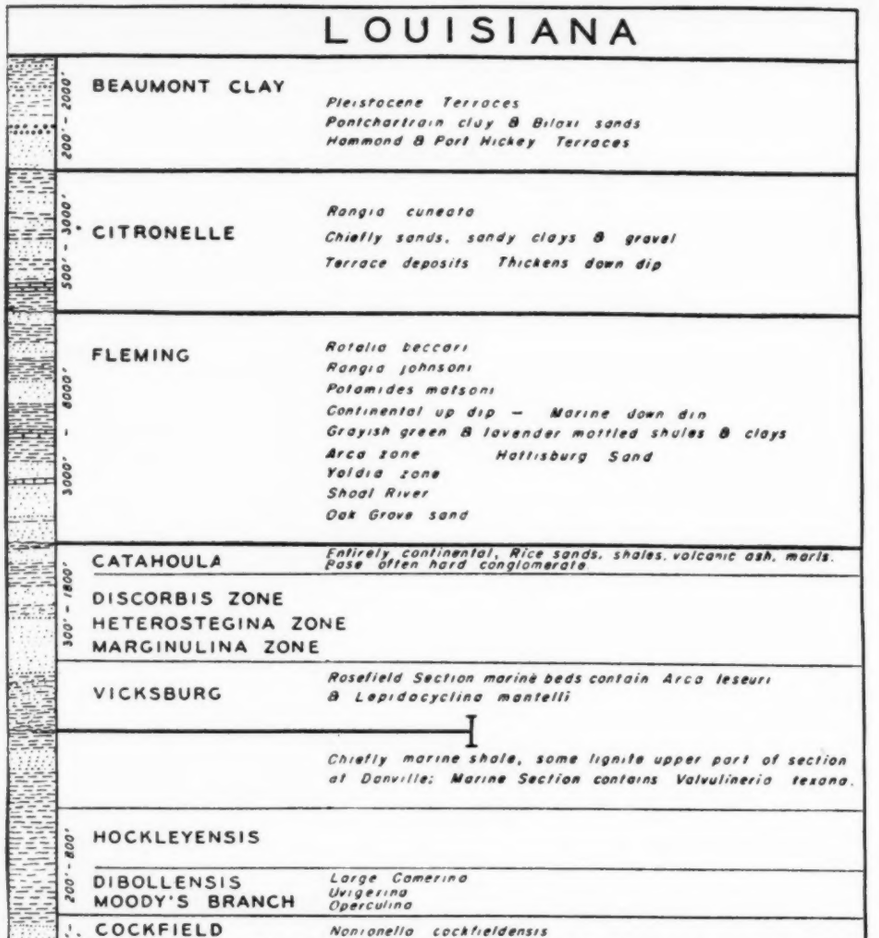
MESOZOIC SYSTEM OF MISSISSIPPI
With Correlations on Northern Louisiana
(Compiled by B. W. Blanpied, Gulf Refining Company, Shreveport, Louisiana)

| | | NORTHERN LOUISIANA | MISSISSIPPI |
|---|---|---|---|
| CRETACEOUS | GULFIAN | Arkadelphia Clay | Owl Creek Tongue / Prairie Bluff Tongue |
| | | Nacatoch Formation | Ripley Formation McNairy sand Coon Creek Fmtn. |
| | | Saratoga Chalk | |
| | | Marlbrook Marl | Houston Marl |
| | | Annona Chalk | Selma Chalk |
| | | Ozan Formation — Ozan Chalk / Buckrange Fm. | Tupelo tongue Coffee Sand/Arcola Ls. Moorfield |
| | | Brownstown Marl | Eutaw Fm. Tombigbee Sd. |
| | | Tokio Formation Ector Tongue | |
| | | Eagleford Formation | Tuscaloosa Formation |
| | | Middle Cenomanian not present | (unconformity) |
| | COMANCHEAN | (unconformity) (Absent on Surface Undifferentiated in wells) Washita Group | Trinity Group |
| | | Fredericksburg Group (Undifferentiated in Wells) | |
| | | TRINITY GROUP / GLEN ROSE SUB-GROUP: Paluxy Formation | |
| | | Upper glen rose formation Anhydrite springers | |
| | | Glen Rose Anhydrite | |
| | | Anhydrite springers Lower C. R. Rodessa Member James-Young Pine Island Member | |
| | | Travis Peak | "Travis Peak" |
| | PRE-TRINITY | Cotton Valley formation Buckner Formation | Schuler Facies. (unconform) |
| | | Smackover Limestone Eagle Mills salt | Not recognized |
| | | | PALEOZOIC |

*Southwest-northeast geologic cross-section of Jackson structure, Hinds and Rankin counties, illustrating truncation of the Tuscaloosa and Eutaw formations from the crest of the structure.*




[2] Ian Campbell and A. D. Miller, "Nepheline Basalt in Richland Parish" Gas Field, Louisiana, Bull. Amer. Asso. Petrol. Geol., Vol. 12, No. 10 (October, 1928) pp. 985-993.
[3] Dugald Gordon, Richland Gas Field, Richland Parish, Louisiana. Bull. Amer. Assoc. Petrol. Geol., Vol. 15, No. 8 (August, 1931) reprinted in Geology of Natural Gas (A Symposium) p. 782.
[4] Dugald Gordon, Op. Cit. p. 782.
[5] Donald J. Monroe, "Jackson Gas Field, Mississippi." Bull. Amer. Assoc. Petrol. Geol. Geology of Natural Gas (A Symposium) page 782.
[6] Donald J. Munroe, Op. Cit. p. 782.




Courtesy, Roper & Todd.

existence of Paleozoic activity received further support considering the cryptovolcanic structure at Jeptha Knob, Kentucky is dated Early Middle Silurian and that at Flynn Creek in Jackson County, Tennessee, is dated post-Leipers (Ordovician) and pre-Chattanooga (Mississippian)[9]. Thus consideration of the Paleozoic province of northeastern Mississippi should not overlook these basic conditions in connection with the origin of the structures. Acidic and basic rocks, probably of the same age associated in most of the igneous rocks localities in the Upper Mississippi valley suggest that magmas at depth underwent differentiation[10].

One of the outstanding structural features of Mississippi is the Little Rock Salient. It marks the line of the buried geosyncline boundary faults of the Appalachian province as it courses from western Alabama westward and northwestward into central Arkansas where it meets the Oklahoma Salient and its associated Choctaw fault.

Definite proof of this regional relationship is indicated by steep dips, ranging from 20 to 30 degrees shown in bedding of cores taken in the Paleozoic at Gulf Refining Company's No. 1 Hamilton, in S. 4, T. 5 N. R. 2 E. in Rankin county on the east side of the Jackson structure[11].

A prominent structural feature of west-central Mississippi is the East Arkansas trough, a syncline downfolded in the Upper Cretaceous rocks; strike of the synclinal axis approximates from N. 18 deg. W. to N. 25 deg. W. It occupies portions of Holmes, Sunflower, Washington and Boliver counties, Mississippi, and Arkansas and Desha counties, Arkansas.

## JACKSON GAS FIELD

The second and largest gas field developed in the state of Mississippi is the Jackson area covering 7,500 proven acres in western Rankin and eastern Hinds counties. The field was discovered on February 28, 1930, from a depth of approximately 2,430 ft. in the Gulfian Cretaceous. By June 15, 1932, 90 gas wells had been completed with a total daily open-flow capacity of more than 2,800,000,000 cu. ft.; at the time only 35 dry holes had been drilled[12]. The gas has a high calorific value, averaging 940 B. t. u. It is used for commercial and domestic heating. Distribution is handled by the United Gas Public Service Company, its subsidiaries, and the Public Service Corporation of Mississippi.

Cumulative gas production from the entire field up to January 1, 1939 was reported at 84,816,231,000 cu. ft.; average recovery of gas per well as of that date was 11,308,830 cu. ft. Sixty-one producing gas wells were scheduled during 1937[13].

Intensive development of the Jackson gas field did not start until the spring of 1930, although commercial quantities of gas were discovered during 1929. The well that served as a major impetus to development was completed on April 2, 1930 by Jackson Oil & Gas Company. Their No. 1 May in Section 2, Township 5, North, Range 1 East, Hinds county was finaled from a total depth of 2,480 ft. for an initial production of 2,000,000 cu. ft. daily. By the end of the year, 48 wells had been drilled; of this total, 32 were gas wells with a total open flow capacity estimated at 941,347,190 cu. ft.

The first well to encounter an oil showing at Jackson was Gulf Refining Company's No. 1 Rainey, in NW NW/4, Sec., 13, T. 5 N., R. 1 E., which made a spray of 13 gravity oil with an initial volume of 15,000,000 cu. ft.

[7] Carl Tolman and Kenneth K. Landes, Contributions to a Knowledge of the Lead and Zinc Deposits of the Mississippi Valley Region, Special Papers, No. 24. Bull. Geol. Soc. Amer., December 30, 1939, Chap. 3, "Igneous Rocks of the Mississippi Valley Lead-Zinc Districts."

[8] Op. Cit. p. 101.

[9] Op. Cit. p. 102.

[10] Op. Cit. p. 103.

[11] Watson H. Monroe, Pre-Tertiary Rocks from Deep Wells, Bull. Amer. Assoc. Petrol. Geol., Vol. 17, No. 1 (January, 1933) p. 45.

[12] Watson H. Monroe, Pre-Tertiary Rocksfrom Deep Wells at Jackson, Mississippi, Bull. Amer. Assoc. Petrol Geol., Vol. 17, No. 1 (January, 1933) p. 45.

[13] State of Mississippi. Section. National Oil Scouts Association.

## Survey of Geophysical Activity in Mississippi

(Report of January 4, 1940)

| COUNTY | METHOD | COMPANY |
|---|---|---|
| Adams | Gravimeter | Fohs Oil Company, Houston, Texas |
| Attala | Seismograph | Stanolind Oil & Gas Company |
| Carroll | Seismograph | Exchange Oil Company (Sinclair) |
| Copiah | Seismograph | S. Wheless |
| Hinds | Seismograph | Wilmut Oil & Gas Company |
| Hinds | Seismograph | Shattock, Dunbar & Tatum |
| Hinds | Gravimeter | Cities Service Oil Company (?) |
| Hinds | Gravimeter | Magnolia Petroleum Company |
| Holmes | Seismograph | Arkansas Fuel Oil Company |
| Holmes | Magnetometer | Kingwood Oil Company |
| Humphreys | Seismograph | Pure Oil Company |
| Humphreys | Seismograph | Pure Oil Company |
| Jasper | Gravimeter | Sun Oil Company |
| Jasper & Smith | Gravimeter | Magnolia Petroleum Company |
| Lauderdale | Seismograph | Westbrook & Thompson, Ft. Worth |
| Lawrence | Gravimeter | Sun Oil Company |
| Leake | Gravimeter | Cities Service Oil Company |
| Leake | Seismograph | Phillips Petroleum Company |
| Lee & Munroe | Seismograph | Carter Oil Company |
| Lincoln | Seismograph | California Co. (Standard Oil Co., Calif.) |
| Madison | Seismograph | Johnson & Johnson |
| Madison | Gravimeter | Arkansas Fuel Oil Company |
| Madison & Yazoo | Gravimeter | Exchange Oil Company (Sinclair) |
| Madison | Seismograph | Carter Oil Company |
| Perry & Forrest | Seismograph | Fohs Oil Company, Houston, Texas |
| Rankin | Gravimeter | Stanolind Oil & Gas Company |
| Rankin | Gravimeter | Carter Oil Company |
| Scott | Gravimeter | Carter Oil Company |
| Scott | Seismograph | Exchange Oil Company (Sinclair) |
| Sharkey | Seismograph | Wilmut Oil & Gas Company |
| Simpson | Gravimeter | Fohs Oil Company |
| Simpson | Gravimeter | Magnolia Petroleum Company |
| Smith | Seismograph | Gulf Oil Corporation |
| Warren | Seismograph | Magnolia Petroleum Company |
| Washington & Sunflower | Magnetometer | Atlantic Refining Company |
| Washington | Seismograph | Fleetborn, Oil & Gas Company, Ada, Okl. |
| Washington | Gravimeter | Magnolia Petroleum Company |
| Wilkinson | Gravimeter | Humble Oil & Refining Company |
| Yazoo | Seismograph | Amerada Petroleum Corporation |
| Yazoo | Seismograph | Exchange Oil Company (Sinclair) |
| Yazoo | Seismograph | Phillips Petroleum Company |
| Yazoo & Holmes | Seismograph | Kingwood Oil Company, Effingham, Ill. |
| Yazoo & Holmes | Seismograph | Carter Oil Company (Standard of N. J.) |
| Yazoo & Holmes | Gravimeter | Carter Oil Company, Tulsa, Okla. |
| Yazoo & Madison | Gravimeter | Continental Oil Company, Ponca City. |

of gas daily from a total depth of 2,505 ft. on completion on July 23, 1930. An initial production of 200 bbl. of 13 gravity oil per day was registered with completion on November 19, 1930 of Love Petroleum Company's No. 1 Maley. The oil flow was turned into earthen storage and was used as fuel in drilling operations; accompanying gas volume was approximately 15,000,000 cu. ft., and about 10,000 bbl. of salt water, from a total depth of 2,494 ft. in the Selma chalk.

### HATCHETIGBEE ANTICLINE

The Hatchetigbee anticline is described by Hopkins [1] as a broad, gentle rock fold approximately 50 miles long and 20 miles broad which extends from a point two miles north of Jackson, Alabama, in a N 55 deg. W. direction past Salitpa, Bladon Springs, and Silas, Alabama, into Mississippi.

The center of the uplift is outlined by the outcrop of the Hatchetigbee formation, the oldest exposed formation in the area. The general size and shape of the anticline is indicated by the outcrops of the Tallahatta, Lisbon, Gosport, Jackson and Vicksburg formations, which encircle the outcrop of the Hatchetigbee formation and formerly arched over it.

The outcrops of the Jackson completely encircle the Hatchetigbee uplift and extend from a point near Salt Creek, north of Jackson, Alabama, norwestward into Mississippi.

The structure of the anticline is asymmetric, the southwestern side having steeper dips than its northeastern. The southeastern edge of the anticline is abrupt, owing to the presence of the Jackson (Alabama) fault, and probably of an unmapped fault at right angles to the fold.

The main axis appears to bend more to the west where it crosses the state line into (Lauderdale County) Mississippi.

However, the axis is not accurately determined, as the anticline is broad and comparatively flat-topped and shows no well-defined axis. The dips on the flank of the anticline reach a maximum of 1 deg. or 2 deg. at a distance of two to four miles from the approximate axis of the anticline.

The Hatchatigbee anticline exposes the Hatchetigbee formation which would normally lie about 400 ft. below the surface.

The Jackson fault is situated east of and adjacent to the Hatchetigbee and is genetically related to it. The upthrown side is on the east; the displacement brings what is believed to be the upper part of the Tallahatta into contact with chimney rock amounting to at least 300 ft. and possibly as much as 400 ft.

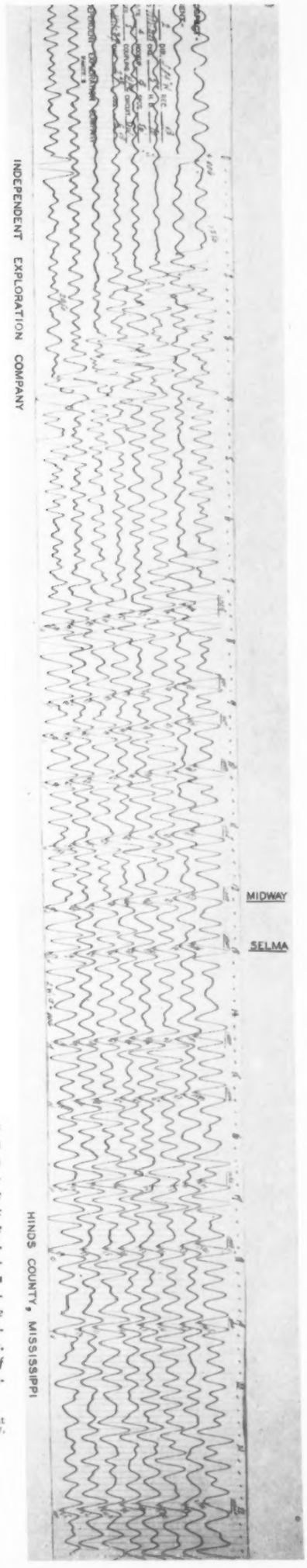
The Jackson fault extends from the southeastern end of the anticline in a southeasterly and southerly direction past the town of Jackson, Alabama, and the Central Salt Works to the Lower salt rocks near Oven Bluff on Tombigbee river.

Exploration by the drill started back in 1902 and during the four ensuing years, six tests were drilled on the structure, but were poorly located with reference to the fold; all were drilled near old salt wells or springs.

No commercial oil or gas production has been developed on the Hatchetigbee anticline as of this writing.

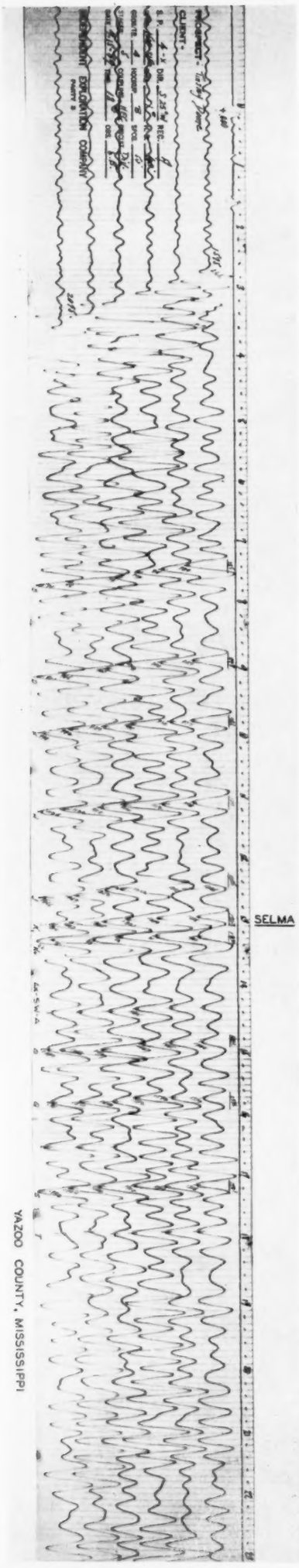
Most recent attempt to seek production on this pronounced structure has been started by B. F. Melat, Trustee, Shreveport, La., operator. Location has been staked for his No. 1 Lockard, in the southwest corner of section 26-7n-15e, in Lauderdale county, Mississippi; it will be drilled to a depth of 3,000 ft.

[1] Oliver B. Hopkins, Oil and Gas Possibilities of the Hatchetigbee Anticline, Alabama. Bull. No. 661-H.: U. S. G. S. 1917.

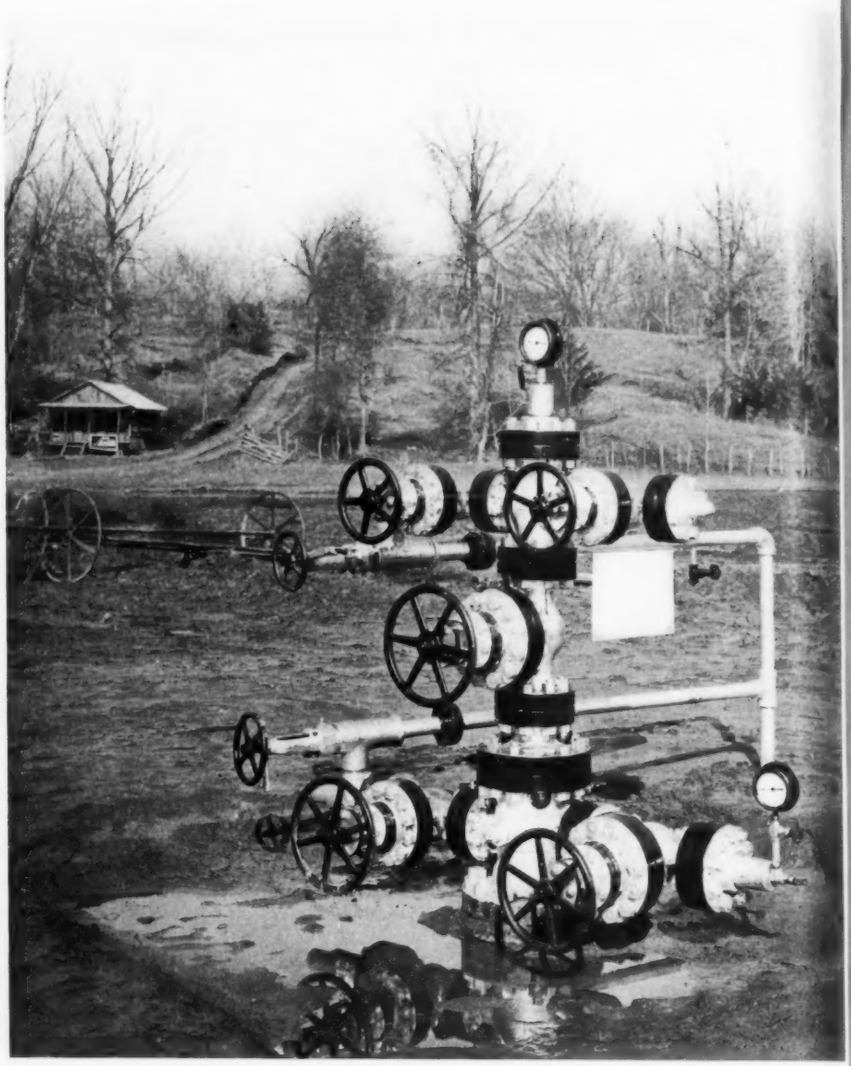



*Seismogram from survey taken in Hinds county in west-central Mississippi in the same geologic province as the Tinsley oil field. Midway and Selma formation markers are indicated opposite respective reflecting horizons. Note presence of five shallower reflecting zones.*

Courtesy, Independent Exploration Company, Houston, Texas.




*Typical reflection seismogram of geophysical survey of Tinsley oil field structure. Reflections from Selma chalk horizons are indicated.*



*Flanged type assembly christmas tree installed at the discovery well of the Tinsley field, Yazoo county; it is Union Producing company, Houston, No. 1 G. C. Woodruff, productive from the Woodruff sand of the Selma chalk formation (Upper Cretaceous age). It has a 6,000-lb. rated capacity.*

Photo, Courtesy Oil Center Tool Co., Houston, Texas.

## PALEOZOIC PROVINCE

Northeastern Mississippi occupies the most southwesterly position on the Cincinnati arch, a broad, low geanticline, 600 miles in length trending north-northeastward paralleling roughly the Appalachian Mountains; the Appalachian Plateaus geosyncline separates this arch from the Appalachian folds, its axis coursing through northwestern Alabama, Mississippian strata cover the arch south of the Nashville dome and between the Nashville and Cinnati domes[15]. The Mississippian yields gas in the Amory gas field of northeastern Mississippi and in the Fayette field of Fayette county, in northwestern Alabama, both related to the major Cincinnati arch. Amory produces from the Hartselle and Bethel sandstones, while Fayette is productive only from the Hartselle.

The West Tennessee Arch traverses that portion of Tennessee extending slightly west of north from the northeastern corner of Tishomingo county, Mississippi into southwestern Kentucky, terminating south of and at right angles to the Rough Creek uplift and fault system.

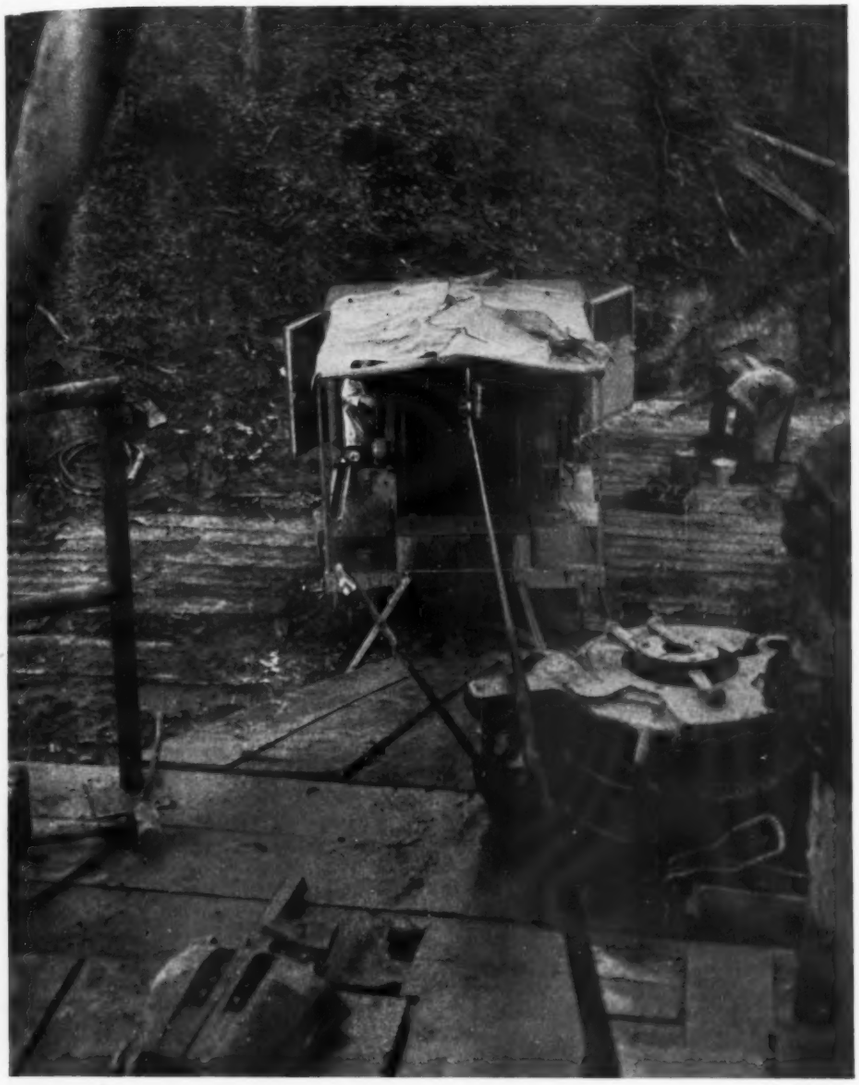
The northeastern boundary of the coastal plain lies west of and parallel to the axis of this arch where its edgeline reaches its most northerly position in the Mississippi valley. It brings to the surface Silurian and Devonian strata.

## STRATIGRAPHY

Stratigraphy of the "Paleozoic province" of northeastern Mississippi (and northwestern Alabama) is well exemplified by the sequence and character of rocks described in the Mississippi Oil & Refining Company's No. 1 Southward well in S. 18, T. 5 S., R. 11 E., in Tishomingo county; offsetting southwestern Colbert county, Alabama. Bramlette[16] states that the uppermost rocks penetrated in this well are the Bethel sandstone and Ste. Genevieve formation of Mississippian age; the Bethel sandstone is fine-grained, gray and

[15] Albert W. Giles, Major Structural Features of the Mississippi Valley. Introduction, Chap. 2, Structural Features of the Mississippi Valley Region and Their Relation to Mineralization. Special Papers, No. 24, Bull. Geol. Soc. of Amer., p. 40, Dec. 30, 1939.

[16] M. N. Bramlette, Paleozoic Formations Penetrated by Wells in Tishomingo County, Northeastern Mississippi. U. S. G. S. Bull. 781-A, pp. 3-8.



*Schlumberger electrical log being taken on a well in the Tinsley field, where it has been successful in determining fluid content, porosity, thickness and position of the pay zones.*

calcareous, which rests on a thin layer of Ste. Genevieve limestone; the Ste. Genevieve rocks are underlain by the Warsaw limestone—yellow-gray cherty, crinoidal limestone. It is succeeded by the Fort Payne chert of lower Mississippian age which is dark yellow-brown chert containing silicified crinoidal limestone. A distinguishing feature is its high degree of silicification, being a pure chert for considerable thicknesses (in this well the interval is 200 ft.). The typical black Chattanooga shale is very thin in Tishomingo county, and its contact with the Fort Payne is described as gradational, a widespread regional condition.

The Chattanooga is underlain unconformably by the Brownsport formation of upper Niagaran age comprising variegated red (ferruginous) and green shale.

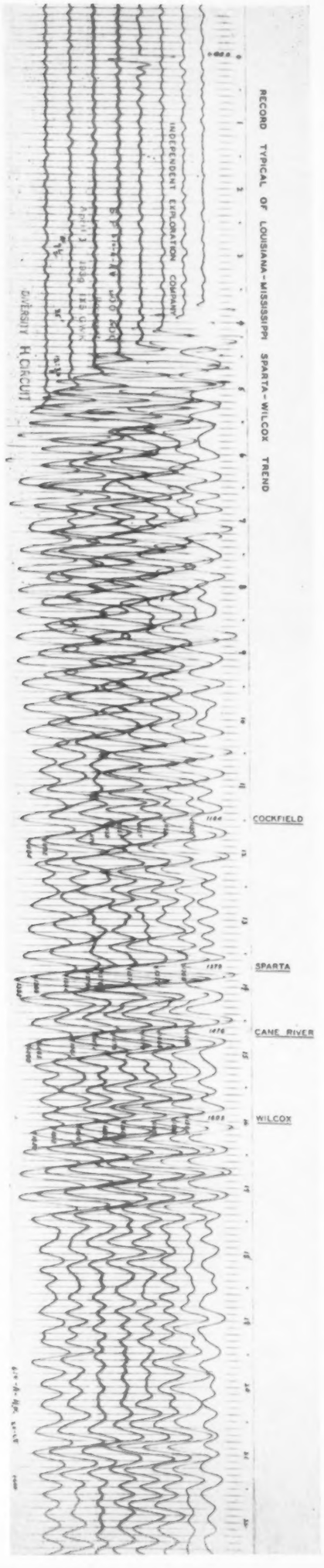
The underlying Wayne formation, of lower Niagaran age, contains (in descending order) the Dixon, Lego, Waldron, Laurel and Osgood members.

Wayne formation is underlain by upper Ordovician rocks including the Leipers, the Fernvale, and the Catheys, Bigby and Hermitage formations. Bramlette believes these impure limestones and sandstones seem to represent post-Black River deposition resulting from the emergence of the Nashville dome and consequent shallow-water conditions.

A sharp lithologic change to a pure lime marks the change to the Kimmswick limestone of late Black river age and the Carters limestone of early Black River (Lowville stage) age; these consist of cream-white to light-brownish-gray fossiliferous limestones with ostracodes.

These rocks are underlain by the Stones River limestone which consists of brown-gray dense argillaceous limestone.

Underlying the Stones river limestone is the Beekmantown dolomite which is described as light-gray dolomite and dolomitic limestone. Two hundred feet below the top of this section, there occurs a 50-ft. series of thin alternating phospatic fine sandstone and pink-gray limestone; this is succeeded by an almost continuous thick sequence of light green-gray dolomite, changing gradually to light brown-gray dolomite, which may be the Knox.




*Typical seismogram from the Sparta-Wilcox-Cockfield trend of Louisiana and Mississippi, where widespread geophysical exploration has been in progress since 1936 accelerated first by the discovery of an interior salt dome in Lamar county in 1937, and more recently by discovery of Sparta-Wilcox production at Eola and Ville Platte in southeastern Louisiana.*

Courtesy, Independent Exploration Company, Houston, Texas.

*Photograph of the discovery well of the new Tinsley field, Mississippi's first commercial oil pool.*

## AMORY GAS FIELD

First gas production discovered in the Mississippi was opened on October 6, 1926 in what is now the Amory gas field in Monroe county in the northeastern corner of the state. The discovery well was Amory Petroleum Company's No. 1 Carter. It found gas at a total depth of 2,470 ft. in the Hartselle sand (member of the Chester series of Mississippian system.) Initial official gauge was 4,552,860 cu. ft. daily.

A deeper gas discovery was recovered 15 months later by Arkansas Natural Gas Corporation's No. 1 Rye, in the northwest northeast northwest of section 22-15s-17w. After finding the original Hartselle sand pay at 2,705 ft. where it gauged 3,186,000 cu. ft. daily, it was drilled deeper finding Bethel sandstone from 3,539 to 3,549 ft. where it gauged 150,000 cu. ft. daily; total depth was 3,710 ft[17].

Four gas wells have been completed in this field proving a total of 160 acres. Accumulative gas production to January 1, 1939 was 960,926,000 cu. ft. Average recovery per well has been 240,231,500 cu. ft.[18]

Principal outlet is the Amory Natural Gas Company. Distribution systems are connected at Amory, Aberdeen, Tupleo and others.

The structure is situated on the southwestward extension of the major Cincinnati Arch which crosses southwestern Tennessee into northwestern Alabama, cutting into Monroe county, Mississippi.

## ORDOVICIAN OBJECTIVE

Due to the prolific yields of the Trenton in northwestern Ohio and northeast Indiana at the northern prongs of the Cincinnati Arch, the Trenton group should be the objective of any deep test drilled in the northeastern tier of counties of Mississippi on the southernmost part of the Cincinnati Arch.

The Trenton group in northeastern Mississippi may be represented by the following formations in descending order Catheys(?) Cannon(?) Bigby(?) but definitely the Hermitage formation.

Charles W. Wilson, Jr.[19] has differentiated the Hermitage formation into seven members, each representing a different facies:

(1) Curdsville limestone,
(2) Laminated argillaceous limestone,
(3) Blue clay-shale,
(4) Laminated argillaceous limestone containing abundant Ctenodonta,
(5) Massive coarse-grained, phosphatic limestone,
(6) Coquina composed of Dalmanella fertilis, and
(7) Irregularly bedded, silt-free limestone interbedded with silt.

## OIL LEGISLATION

First legislation relating to oil and gas production was enacted during 1932 by the Mississippi legislature designated as Senate Bill No. 89; it became Chapter 117 of the laws of 1932, but was amended during 1934 and 1936. This act created a State Oil and Gas Board comprising the Governor, the Attorney General, and the State Land Commissioner. In addition, it created a new office, that of state oil and gas supervisor, H. M. Morse is the present supervisor, with offices in Jackson. The Supervisor is appointed by the Governor for a four-year term, according to the provisions of the act, but his choice must be ratified by the Senate.

The 1936 amendment to the act provided for the proration of oil and gas in the event that full production of oil or gas from any common source of supply can be obtained only under conditions contributing to or constituting waste. In addition drilling permit fees of $25 each are levied to support the board's expenditures.

In applying the law, the State Oil and Gas Board established a 40-acre spacing pattern and rule. Only one exception to this rule was allowed in the granting of a permit during December to R. B. Sanders of Dallas who had previously been refused permission to drill on the 17.95-acre Milner tract. At the rehearing on his application, Sanders appeared with letters, telegrams and statements from the owners of adjacent leases and royalties in which it is reported they declined to join him in pooling acreages to form drilling squares of 40 acres to the well; on this basis, the commission promptly granted the permit. Purpose of applying the 40-acre spacing rule is indicated to prevent dissipation of reservoir energy through overproduction.

The law provides against waste including the requiring of permits to drill, protection of wells from infiltrating water, and the general prevention of waste by use of improved methods of drilling, and production, the plugging of dry or abandoned wells, the shooting of wells, the testing of casings, cementing of wells, and metering of gas. In addition, producers are required to prepare and file monthly reports showing the amount of oil and gas taken from each well each month; gas wells are required to be checked yearly when open-flow capacity tests are taken.

Prior to April, 1938, $900,000 was realized from the total sales of the land commissioner's office for the preceding 10-year period. However, state land sales have valued during the past one and a half years during which time interval a total of $800,000 was received by the state.

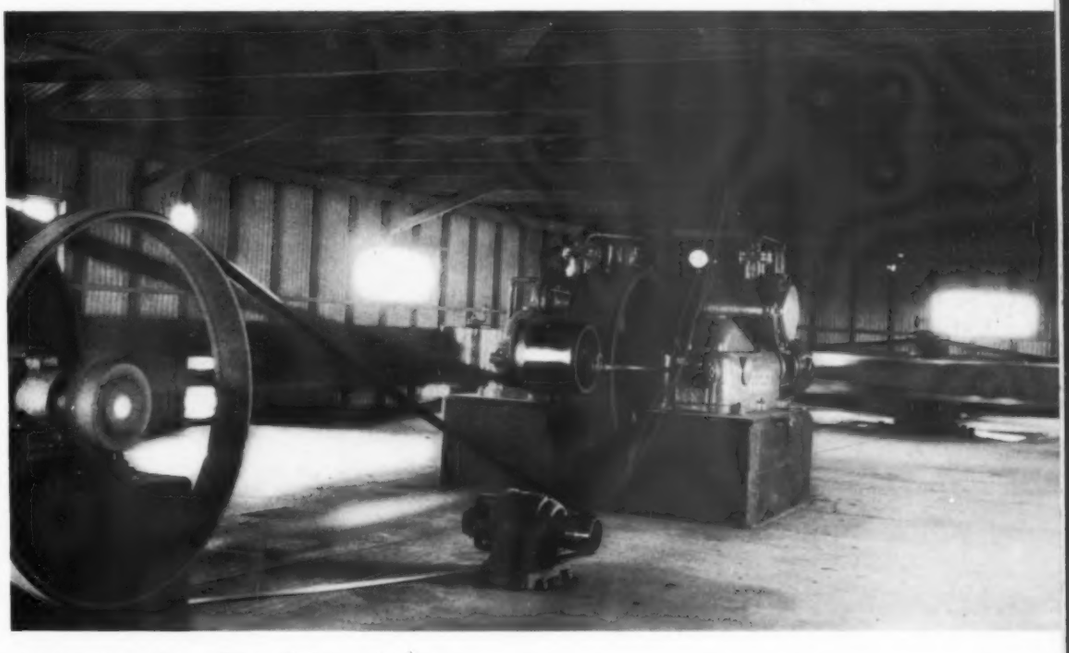
However, in December, 1939, Governor Hugh White announced that the state had discontinued leasing sixteenth section land, except under special circumstances (leases on sixteenth section lands are granted by the county boards of supervisors, but must have the approval of the state government).In the announcement, the Governor said that "of course, if one of these sections constitutes part of a block and development cannot be had without the leasing of it, then we will do our part toward promoting development, but all leasing of this land in the future must be strictly bona fide on the part of everybody."

Earlier, the state had declared a moratorium on issuance of land patents on tax-forfeit lands and had developed strict regulations covering the leasing of all state-owned lands. On November 15, the Mineral Lease Commission announced requirement of prompt and continuous development of any state lands leased for oil or gas. At the time, in approving two applications for state lands, the commission agreed that, hereafter, all contracts would require that a test be drilled on state property within 90 days if oil were found on a block of land which included acreage leased partly from the state and partly from private individuals. The commission also ruled that should the first test on any block of land including state acreage be a dry hole, the holder of the lease would be required to drill a second well in the block within six months or forfeit the lease.

[17] Willard F. Bailey, Symposium Geology Natural Gas, Southern Cincinnati Arch Region, p. 873.
[18] Year Book, National Oil Scouts Association, Mississippi, 1937.
[19] Charles W. Wilson, Jr., Hermitage Formation (Trenton Group). In Tennessee American Association for the Advancement of Science, Section E, December, 1939 Meeting, Columbus, Ohio. Abstracts Bull. G. S. A. Vol. 50, No. 12, Pt. 2, Dec. 1, 1939, p. 1, 993.

# OIL CONSERVATION by Private Initiative

**By J. C. Albright**



*Interior of power on Burnough lease, showing compressor driven by power engine, Shasta Oil Co's repressuring project in Cotton Co., Okla.*

FIVE hundred barrels of oil per day for almost six years, fully 290 bbl. per day more than that anticipated by ordinary primary producing methods at this date, is the story of Shasta Oil Company, that is operating its Walters, Oklahoma properties under a repressuring program. The methods employed on this project of about 450 acres are not intricate, the operation relatively inexpensive, and requiring no elaborate installation of compressors to obtain the desired results consistently, day after day, and month after month.

The group of leases which are operated in the secondary recovery project are in the pool known as the Walters field, a few miles northeast of Walters, in Cotton county, Oklahoma. The formation in which the production is obtained is the Priddy sand, lying on an average of 2,200 ft. below the surface, where the elevation ranges from 990 to 1,050 ft., governed mainly by the rolling terrain. This field was discovered in 1917, developed rapidly until 1920, and extended by Shasta Oil Company in 1929. The sand is not distributed uniformly over this area, indicating from cuttings recovered from the formation that it could have been a narrow shore line, the bars of which are cut here and there by tidal inlets which in ancient times connected marsh areas with the open sea. Over wide areas the sand is arkosic and of low porosity and permeability. Local areas within the producing zone show coarse, clean sand made up of rounded grains of clear quartz where the worth-while recoveries of oil have been obtained. A core taken from a well drilled when the project was begun shows that the Priddy sand, in that area, has a porosity of 21.9 percent, and a permeability of 1883 Millidarcy's.

The original wells in this pool were produced by flowing in the flush period, but were soon put on the pump, using central powers, surface rod lines, jacks and the usual type of tubing, sucker rods and working barrels. Approximately 2,100,000 bbl. of oil have been recovered from the Priddy sand on the approximate 450 acres of Shasta Oil Company leases since the first wells were drilled. When a project to institute a program of secondary recovery of the oil remaining in the sand was considered in the spring of 1933, a thorough search of well records was made by J. H. Cable, consulting petroleum engineer, who was retained by Shasta Oil Co., to supervise the preliminary operations.

Water in great quantities was known to be in this sand, down dip from the producing zone, and which had indicated that it would encroach rapidly if methods were not worked out to prevent. After the initial work had been done, the input, or key wells were located, mainly on pattern, but 14 of the total of 20 were located along the known water encroachment line. The key wells were selected from original producers, rather than drill a greater number of holes on the property, which would increase the investment and operating expense.

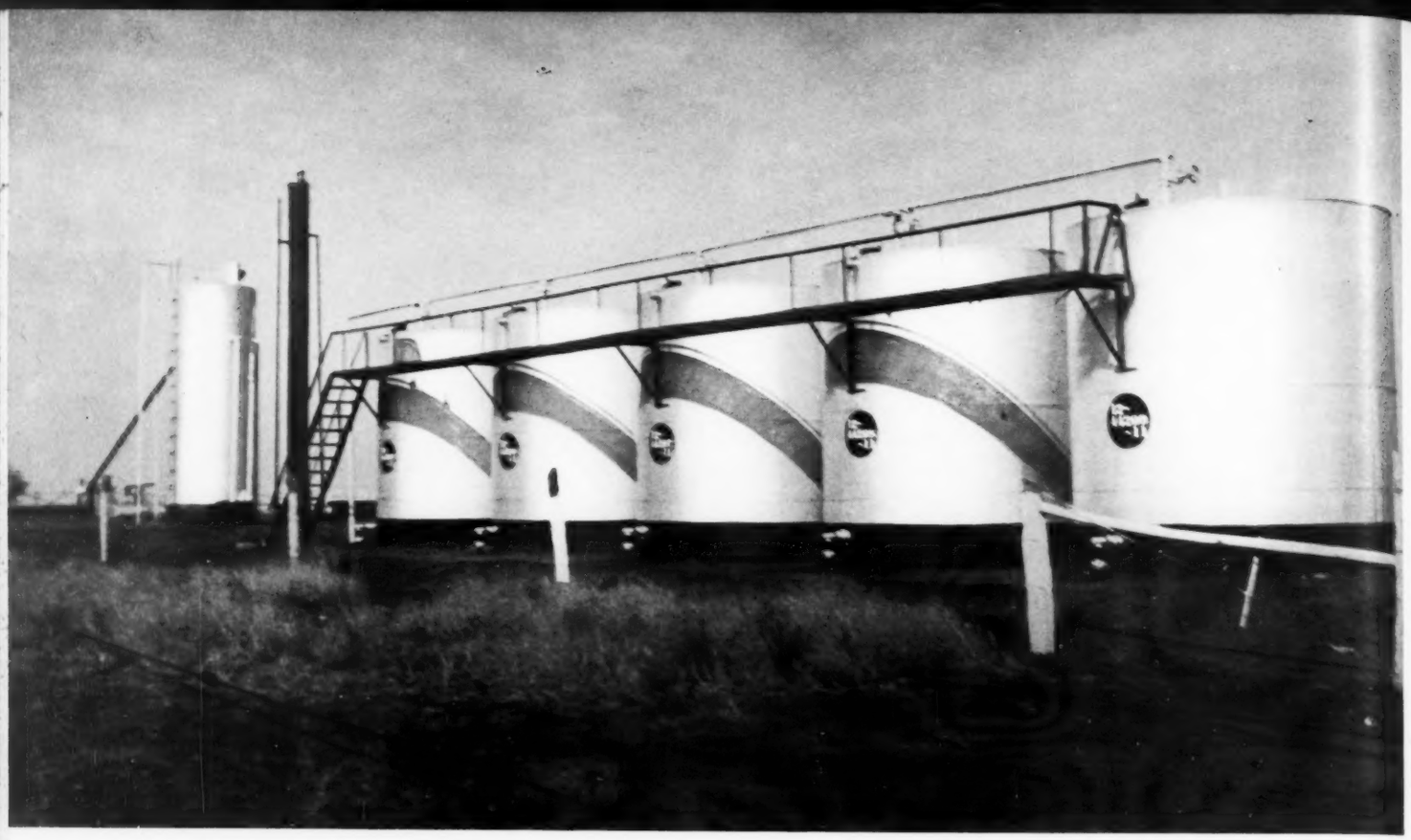
All of the key wells selected for introduction of the gas to the sand were thoroughly cleaned of loose sand and the accumulation of foreign material usually found in old wells at the bottom. Some of the key wells were equipped with a string of tubing with a packer which was set at a predetermined point in the sand. This method was applied to these wells so that the force of the gas would permeate and flow through the lower section. Shale partings in the sand were the guide when setting the packers which would prevent the vertical travel of the gas in these wells so that a greater ultimate recovery of oil might be obtained from all sections of the producing formation.

To handle the repressuring gas, which averages 769 std. cu. ft. per barrel of produced oil, compressors were installed in the central powers, located at various points on the property, and driven by belts from a pulley on the opposite side of the engines from the power take off for the band wheel eccentric surface rod operating mechanism. These compressors are horizontal, two cylinder machines with a self contained intercooler for the gas between stages of compression. They were located in the central powers so that the lease men who attend to the various duties on the properties can service these units as well as the ordinary pumping equipment without the necessity of having separate crews.

The gas which is produced from the wells with the oil, averaging 858 std. cu. ft. per barrel of produced oil is removed from the oil in low pressure vessels at the lease tank batteries. It is gathered from these separators by a system of pipelines which leads to all compressors in a common system. These gathering lines, as well as the discharge lines from the compressors to the key wells are looped throughout the system.

Two objectives were in view when the project was initiated. The first and major consideration was that of obtaining a much greater recovery per acre than normally expected by ordinary primary methods for a given period. The second objective was that of slowing down the encroachment of water from the southeast, and to prevent this water from traveling up-structure faster than the oil might be removed from the pore spaces of the sand. Both objectives have been attained with the water being held to a very slow rate of travel. The oil production is being held at a constant recovery rate.

The gas from the wells contains only a small amount of condensable fractions, which is not considered as possible production and no provisions are provided for the recovery as gasoline. It remains in the gas and is recycled back into the sand through the key wells. The lines carrying the gas under pressure are laid over the field on surface contours to prevent the pocketing of condensate



*Stock tanks and separators on Patterson lease, Shasta Oil Co.'s repressuring project.*

and water vapor. Drips of adequate capacity are installed at strategic points along this system to remove the liquids from the piping as rapidly as they accumulate and reach the sags and unavoidable low lying sections of the system. In summer the weather is sufficiently warm to prevent the condensation of gasoline, but in winter, when the weather becomes extremely cold the drips accumulate small quantities of liquids which are removed in the usual manner.

When the equipment had been installed on these properties, Jo H. Cable was retained to supervise the operation and advise with the production superintendent concerning the proper volumes of gas, the rate of input and the behavior of the producing wells. The project was ready to start about the first of December, 1933, at which time about 200,000 std. cu. ft. of gas was introduced back into the sand, through the key well each day. This procedure was maintained consistently until the spring of 1934. At that time, the volume of injection gas was increased to about 400,000 std. cu. ft., and continued until the present. The production of oil during the latter half of 1933 declined from a July peak of 600 bbl. per day to 460 bbl. per day in December. Because of the action of the gas in moving the oil from the pore spaces of the sand, the production mounted through the first quarter of 1934 to about 500 bbl. per day.

Over a two year period, from January 1932 until January 1934, the properties, produced by conventional pumping, fluctuated from a high of 830 bbl. per day in June, 1933, to a low of 460 bbl. per day in December, 1933. Throughout 1934, the production, by gas injection was maintained at about 480 bbl. per day, but in 1935, the production was increased, when the amount of gas was also increased, to above 500 bbl. per day.

A decline curve was projected from the first of July 1932, until January 1st, 1942, employing approved methods used by petroleum engineers when evaluating a producing property. For the first 18 months, normal decline curves were followed, which were expected to decline at the usual rate by lifting the oil under normal primary methods. According to this curve, the 450 acres would not have produced in excess of 250 bbl. per day by the first of 1937, and, by the 1st of July, 1939, the production should have been only about 180 bbl. per day. At the end of the projected period, the entire property would have been producing about 150 bbl. per day. But by applying the principles of repressuring to these leases, the production was held to above 500 bbl. per day from the inception of the project until the present. During September, 1939, the actual pipeline oil pumped from the wells averaged 514 bbl. per day, actually 329 bbl. per day more than would have been produced if repressuring had not been applied.

*Manifold which may be used for gauging individual wells in repressuring project.*

When lifting the oil from the producers in this repressuring project, the wells are all equipped with standard two inch tubing and $\frac{5}{8}$ in. sucker rods. A portion of the wells have standard working barrels, and others were equipped with barrels having insert liners. In all wells, however, a flood nipple is attached below the standing valve so that the kick-off is always above the top of the sand. Regulation jacks are installed above the casing-heads which receive their power through surface rods pulled by the central powers containing the gas compressors. The jacks are adjusted for an average stroke of about 15 in., and the timing varies from eight to eleven strokes per minute.

A slow motion and a short stroke are used to keep the well on production as long as possible, and the flood nipple is used to keep the face of the sand from becoming exposed above the level of the fluid. By maintaining a high level of oil, covering the face of the sand, not only is the sand face prevented from a possibility of becoming dry, but the gas is held within the body of the producing formation and thus prevented from increasing the produced gas/oil ratio.

When operating a repressuring project, there is always the possibility of the gas channeling directly from an input well to some producer. But channeling in the sand of this project is prevented from advancing beyond an incipient stage by increasing the back pressure of the gas in the casing—if the production gas/oil ratio indicates that such a state is being developed—and, like other projects, the pressure of the gas in the casing annular space varies from well to well.

The pressure necessary to deliver the gas through the input well to the sand varies from 18 to 225 lbs. gauge. The wells which were originally drilled and penetrated the localized areas of greatest permeability require the lowest pressure, and those which were drilled in areas where the ancient tidal inlets were located require the highest pressure, because of the mixture of silt and other material in the sand.

Because of the gradual water encroachment from the southeast, it is only natural that some water is produced with the oil, particularly from the wells which are located at this time, below the 1939 water encroachment. To recover the oil from the mixture of oil and water, or clear water alone, bootlegs are installed at all flow tank batteries into which the oil, gas and water flow from the lead lines. At this point also, is a lead line manifold which is provided for the purpose of gauging any individual well to determine its production separately from the others.

The bootlegs remove the easily precipitated water from the oil, which is siphoned out as in the conventional gunbarrel tank. The oil and gas flow from the bootleg to a second tank where the gas is removed. To break out the water, small lubricator-type chemical feeders are set near a rod line and operated in the same manner as a pipe line jerker pump. An extra reservoir is set beside the chemical feeders so that the operator will not be forced to visit the installation more than once a day.

Heating is necessary for the proper breaking of the water, and each battery has an individual gas fired unit made of casing. The heater lies almost flat on the ground, and consists of two joints of pipe, one within the other. The inside pipe is the combustion section, and extends through to the opposite end, terminating in a pipe stack to dispel the products of combustion. A thermostat controlled burner is installed in the firing end of the heaters, which maintains a definite temperature on the oil after the initial adjustment has been made.

Measuring instruments for the key wells consist of recording orifice meters at such places as wells which need daily checking with a record being made of the volume introduced, but wells which have shown themselves to be consistent in taking the gas are fitted with indicating, mercury filled manometers and indicating pressure gauges. The repressuring of these wells is controlled principally on the basis of gas/oil ratios which are taken on each producing well every two weeks or oftener, as conditions justify or when a suspicion of increasing gas is had by the production men. Whether the gas to the key wells is measured by recording orifice meters, or by the manometers on the orifice flanges, the amount of gas going to each key well is measured daily and a record made for the office of the company, and a copy sent to Jo H. Cable in Wichita Falls, Texas.

The operation of the repressured properties of Shasta Oil Co., is shown in the accompanying tabulation.

**For September, 1939.**

| | Std. cu. ft. | Cu. ft./day |
|---|---|---|
| **INPUT GAS** | | |
| Produced gas | 10,684,200 | 362,800 |
| Purchased gas | 995,400 | 35,180 |
| Total injection | 11,879,600 | 366,000 |
| **PRODUCTION** | Bbl. | Bbl./day |
| Oil | 15,425 | 514 |
| | Std. cu. ft. | Cu. ft./day |
| Gas | 13,221,300 | 440,700 |
| **RATIOS** | | |
| Injected gas/oil ratio | 760 std. cu. ft./bbl. | |
| Produced gas/oil ratio | 858 std. cu. ft./bbl. | |

By comparing the actual production as plotted on the production decline and gas injection graph with the normal decline curve, it may be seen that there would have been only about 5,550 bbl. produced for the month of September if repressuring had not been applied to the leases. With repressuring the actual production was almost 10,000 bbl. greater. As the field becomes older, the down dip encroaching water may be allowed gradually to rise over the structure at a profit, to form a combination of recovery by repressuring and a natural water flood. The story of this property is one in which a greater present recovery has been obtained at a cost not greatly exceeding the usual primary methods, and one in which it is obvious that natural resources are being conserved by removing the oil from the sand at a time when it may be done without being reduced to a stripper field.

*Lubricator used by Shasta Oil Company in repressuring project near Walters, Oklahoma, to feed chemicals into lead line to break emulsion and water from oil.*

Those attending the first meeting of the proposed New York Chapter were:

J. H. Baird
H. B. Book
I. Frank Brown
F. L. Convers
Robert Cummings
A. A. Dill
L. G. Ensign
W. S. Fellows
G. S. Flanders
L. F. Griffith
H. E. Maland
W. P. Laseter
W. J. Maloy
F. J. Olson
F. T. Ostrander
E. L. Racek
William Siems
J. A. Thomas

*Left, S. D. Beckley, H. B. Book, Robert Cummings, P. J. Van Wert, C. J. DeLay and E. W. Mayo: below, E. L. Racek, G. W. Hamill, I. Frank Brown, Henry W. Pullman, President John Baird, W. J. Molloy, A. A. Dill and F. L. Convers.*

# New York Chapter of Nomads Organized

## Meeting at Canadian Club

## Submits Petition to Board

## of Regents for Charter—35

## Attend Meeting

NEW YORK, MARCH 5TH.

IN RESPONSE to invitations sent out by John Baird, some 31 export representatives of oilfield equipment manufacturers assembled at the Canadian Club in the Waldorf Astoria Hotel in New York for the purpose of organizing a New York Chapter of the Nomads. All of those attending, had of course, travelled abroad in the interest of manufacturers or distributors of oilfield equipment, and had come together for the purpose of submitting a petition to the Board of Regents of the National Oil Equipment and Delegates Society requesting a charter for the new chapter.

As described in the December issue of WORLD PETROLEUM, the Los Angeles chapter was the first organized in the fall of 1938 and now having about 65 members. Subsequent chapters were organized in Houston and Tulsa.

*Left, L. F. Griffith and F. J. Jobst: right, S. J. Gallay and W. J. Molloy.*

*Above, J. W. True, J. F. Jobst, E. T. Landzraff, H. E. Maland and F. J. Olson: right, T. E. Ward, H. B. Cheswick and A. L. Woracek.*

E. H. Trammell
T. E. Ward
V. R. Wittich, Jr.
G. R. Woods
A. L. Woracek
S. D. Beckley
C. J. DeLay
E. T. Landgraff
H. B. Cheswick
G. A. Hamill
J. W. True
P. J. Van Wirt
F. J. Jobst
Lloyd Cain
S. J. Gallay
E. W. Mayo

Others who had been invited to sign the original petition but were unable to attend were:

E. H. Bishop
L. V. Boggs
W. J. Campbell
G. E. Daniels
W. S. Evans

*Below, V. R. Wittich, Jr., G. S. Flanders, L. G. Ensign, W. P. Laseter and W. H. Siems.*

E. A. Gretzler
Thad Putnam
A. V. Simonson
G. M. Stewart

This meeting was also attended by Henry Pullman, Sergeant-at-Arms of the Los Angeles Chapter. Mr. Pullman gave a brief talk on the purposes of the organization. The organization is of course, of a purely social character and presents an opportunity for men who have travelled abroad with a common purpose to get together to exchange views and to discuss their interesting experiences in the remote corners of the world where oilfield activity is being carried on. In addition, the club furnishes a central point for the entertainment of visiting oil men from foreign fields, who have in many cases extended hospitality to members of the Nomads organization during their travels abroad.

Following dinner, election of officers was held and J. H. Baird was elected president of the chapter, with W. J. Campbell as vice president. E. H. Trammell was elected Secretary-Treasurer and A. A. Dill, Assistant Secretary-Treasurer. Charged with the responsibility of arranging entertainment were I. Frank Brown as Sergeant at Arms and Val Wittich, Assistant Sergeant at Arms. In accordance with the original constitution, two regents were elected: J. H. Baird and W. J. Campbell, who will join the regents from the other three chapters in general supervision over all the chapters and for the purpose of issuing subsequent charters to local chapters that may be formed in future.

Among those attending the meeting were the two men who first acted as export representatives in New York City for oilfield manufacturers; F. T. Ostrander who started in 1917 and Fred Convers who started in 1919.

The next meeting was called for the first Monday in April which will be April 1st. Subsequent meetings will be held once a month.

*Left, E. H. Trammell and J. A. Thomas: right, pioneers in the export representative field, Fred Convers and F. T. Ostrander.*

# TIDE WATER ASSOCIATED
## Oil Company Promotions

**Bert Graves comes to New York to head Eastern Division—**

**Numerous Promotions Increase Responsibilities of men who Have Served with The Company for from 12 to 30 Years.**

How the operations of Tide Water Associated Oil Company are conducted through the Committee form of administration was explained in an article in the January, 1940, issue of WORLD PETROLEUM. That story was told then by William F. Humphrey, President, incident to his announcement of the resignation of Edward L. Shea and the discontinuance of the office of Executive Vice President Then at the end of January, Noel Robinson resigned as Vice President and Director of Tide Water Associated to become Vice President and Director of South Penn Oil Company.

*Top right, Bert I. Graves, recently arrived in New York from the west coast to head up Tide Water's eastern operations.*

Bert I. Graves has been brought from California to New York to head up the company's Eastern operations. On February fifteenth he became Chairman of the Operating Committee in charge of the Eastern Division. He will continue as a Vice President and a Director of the company. Mr. Graves has been a motivating factor in the company's activities on the Pacific Coast and took an active part in many of the constructive activities undertaken by the California oil industry. Through his inspiring leadership and the *espirit de corps* he engendered among the sales personnel, the company's volume of sales for its Western Division increased greatly during his administration. He leaves his mark indelibly on the West Coast in the form of the "Flying A" trade mark which has been so popular there for the past several years as the company's trade name and symbol for its gasoline. It has recently been adopted in all of the company's marketing areas throughout the country. As President of the Golden Gate Exposition Petroleum Exhibit, Inc., the petroleum industry's contribution to the Pacific Coast's International Exposition on Treasure Island, Mr. Graves played an important role in making that exhibit one of the most popular and attractive at the Exposition.

Since the day more than thirty years ago when Mr. Graves started as a clerk in the pipeline subsidiary of the old Associated Oil Company, he has had a wide and varied experience in the oil business that particularly equips him for his new job as head of the company's Eastern operations. Not only has he been employed in the company's various domestic branches of the business, but in 1922 he was sent to the Orient as General Sales Representative and had headquarters at Shanghai, China, until he returned to this country in 1925 to become Assistant to the then Vice President in Charge of Sales. In

*Left, George T. Hanks above, and Harold F. Parsons below.*

*Right, George J. Murray, Jr. and L. D. Jurs.*

1929 he was appointed General Sales Manager and a few years later became Vice President in charge of Sales on the Pacific Coast. With the formation of Tide Water Associated as an operating company in 1936 by the merging of Tide Water Oil Company and Associated Oil Company with and into the then holding company, Mr. Graves was elected Vice President and Director of that company.

Bringing Mr. Graves to New York to head its Eastern operations is another milestone in the progress of Tide Water Associated. His initiative, far-sightedness, and his varied experience together with his natural characteristic of leadership should prove very beneficial to the company.

George T. Hanks has been appointed Vice Chairman of the Operating Committee of the Eastern Division. He was elected a Director of Tide Water Associated to fill the vacancy created by Robinson's resignation at the end of January. Mr. Hanks is also Vice President in charge of Transportation and Supplies for the Eastern Division of the company. He has been associated with Tide Water Associated and its predecessor companies for the past twenty-five years, having joined the old Tide Water Pipe Company, which was originally the parent company of Tide Water Oil Company and which constructed the first pipeline to transport crude oil from the Pennsylvania fields to the Eastern seaboard. Mr. Hanks spent his early years with the company in various positions and in 1933 was brought to the New York office to take on the responsibility for the company's production in the Bradford field, supervision of its Eastern fleet of tankers and Mid-Continent pipeline operations, as well as the lines from the Pennsylvania fields that serve to supply the company's crude requirements at its Bayonne Refinery.

Harold F. Parsons has been appointed Assistant Vice President and Manager of the New York Crude and Products Department to aid George Hanks in the activities of the Eastern Transportation and Supply Division. Mr. Parsons has been with the organization in its New York office for about twenty-two years. Until his recent promotion he was Assistant to the Executive Vice President, which position was recently abolished incident to the resignation of Edward L. Shea.

A new post has been created in Tide Water Associated's administrative organization to bring about a closer coordination and development of the company's public relations activities. George J. Murray, Jr., who has been with Tide Water Associated and its predecessor companies for the past eighteen years, has been appointed Manager of Public Relations. His activities will embrace developing and maintaining public good will, publicity, relations with stockholders, governmental bureaus and statistical and corporate agencies, and memberships and subscriptions to outside organizations. Mr. Murray began his career with the company in a clerical position at its Bayonne Refinery and until his recent promotion was Assistant to the President.

The Operating Committee of the Mid-Continent Division continues under the leadership of Edward H. Salrin as Chairman and Ralph B. Pringle as Vice Chairman, both of whom are also Vice Presidents and Directors of the company.

Lloyd F. Bayer, Vice President in charge of Manufacturing and a Director of the company, continues as Chairman of the Operating Committee of the Western Division, but with the removal of Mr. Graves to the East the position of Vice Chairman of that Committee became vacant. Lou D. Jurs, Vice President in charge of Transportation for the Western Division, has been appointed Vice Chairman of the Committee. Mr. Jurs has been a Director of Tide Water Associated since 1936 and will continue as a Vice President of the company. He has had a varied experience in the transportation, manufacturing, and sales branches of the business during his twenty-eight years of service with the company.

The promotion of Mr. Graves also brought about several important changes in the sales personnel of the company's Western Division.

Percy E. Allan succeeds Mr. Graves as General Sales Manager of the Western Division. He, too, has had a long record with

*Top row, left to right, W. A. Reanier, J. M. Evans, H. A. Jackson and E. J. Heinz.*

*Right, top to bottom, J. J. Lermen, Jr., R. J. Irvin and E. B. Bronte.*

*Left, P. E. Allan, general sales manager, Western Division.*

the company, beginning in the Accounting Department in 1915 and moving into the Sales Department soon after he returned from the Army after service in the World War. He moved up step by step in the sales organization until in 1929 he was appointed Domestic Sales Manager in which position he had supervision of the entire Domestic Sales Department on the Pacific Coast under Graves' administration. In his new post as General Sales Manager of the Western Division, Mr. Allan will have complete charge of all sales for the Western Division.

W. A. Reanier who for the past nine years has been Manager of White Oil Sales, succeeds Allan as Domestic Sales Manager. Mr. Reanier's service with the company covers a span of twenty-four years, beginning as a plantman at one of the company's distributing stations and carrying on successively through various sales operating positions on the Pacific Coast.

J. M. Evans who has been with the Company and its affiliates for the past eighteen years, becomes Assistant Domestic Sales Manager and H. A. Jackson succeeds Reanier as Manager of White Oil Sales on the Pacific Coast. Jackson's service with the company began nineteen years ago as a plant clerk and since then he has moved up through various operating positions to that of District Sales Manager at Seattle, Washington, from which position he now again moves up to become Manager of White Oil Sales.

E. J. Heinz succeeds Jackson as District Sales Manager at Seattle after 19 years of service in various sales positions with the company.

J. J. Lermen, Jr. who last June was appointed Foreign Sales Representative for the company, stationed at Tokyo, Japan, will return to the United States next summer to assume the duties of Export Manager to which position he has recently been appointed. Mr. Lermen's services with the company started in 1923 as a service station salesman. He later became a tester in the laboratory of the company's Avon Refinery and then moved back to the Sales Division and filled various positions until he was sent to Manila in 1937 as Assistant to the Manager at that point and then to Japan in 1939.

J. H. Farry becomes Assistant Export Manager after sixteen years of service beginning in the Accounting Department and later moving into the Sales Division to fill various posts until his recent promotion.

R. J. Irvin becomes Supervisor of Reseller Accounts in the company's general office at San Francisco after nineteen years of service in various sales positions with the company. The position of District Sales Supervisor which he vacates, goes to Emory B. Bronte, who for the past seven years has been San Francisco Sales Agent for the company. Mr. Bronte has been with the company for thirteen years.

George M. Dixon succeeds Mr. Bronte as San Francisco Sales Agent. Mr. Dixon started with the company as a service station salesman in 1928 and served as Assistant Manager of Aviation Sales under Mr. Bronte, later succeeding to the post of Manager of Aviation Sales in 1933.

In announcing the various promotions in Tide Water Associated, President Humphrey pointed out that they are all in keeping with the company's long established policy to promote from within the organization and that "all of these men have risen to executive positions from the ranks during their long periods of service. It is interesting to note their services with the company range all the way from twelve to thirty years."

# Building Provided for Foreign Visitors to TULSA OIL SHOW

TULSA, OKLA., FEB. 27

GROUND was broken on February 26 for the International Delegates building on the grounds of the 1940 International Petroleum Exposition with accompanying appropriate ceremony by members of the Tulsa chapter of the Nomads club, according to W. G. Skelly, president of the Tulsa oil show.

The building, donated by W. R. Braden of Tulsa, will serve as headquarters for attending international delegates, Skelly said, and members of the Los Angeles, Houston, and Tulsa chapters of the Nomads club will act as hosts in the building during the week of the exposition.

Following a visit of Dr. Carlos Perez de la Cova, administrative head of the petroleum department for the Ministry of Fomento, Venezuela, and J. Martorano, representing the petroleum department of that country, recommendations were made to the Venezuelan government for the construction of a building on the exposition grounds to house the exhibits from that South American country. The two representatives made a tour of the grounds during their visit to Tulsa.

Advance lists of countries from which delegates are expected to attend include a greater number of nations indicating greater attendance than in any previous year, Skelly pointed out. Included among the countries from which delegates will attend, according to the early notifications, are: Great Britain, Canada, Venezuela, Greece, Turkey, Mexico, Germany, Italy, Colombia, S. A., Dominican Republic, Cuba, and Trinidad, B. W. I.

Increased activities and preparations for the international visitors include the naming of three committees to serve in place of the one of previous years. Barton A. Myers, director, International Petroleum Co., Ltd., Toronto, Canada, will head the foreign attendance committee; Alf G. Heggem, vice president of the exposition, is chairman of the committee for entertainment of foreign delegates; and James H. Gardner, Tulsa oil man, is in charge of the committee on arrangements for international visitors.

Plans for caring for the international delegates will include the establishing of two registration headquarters in place of the usual one of previous years. One of these will be located in the new international building on the exposition grounds, while the second will be in downtown Tulsa. Cars will be provided to transport the international delegates to and from the grounds and to any destination they may desire. In addition, they will be taken on a conducted tour of oil fields and refineries near Tulsa.

An international delegates banquet is being planned by the committee under the direction of Heggem, with committee members including representatives of the Los Angeles, Houston and Tulsa chapters of the Nomads club.

Several individuals from other countries have already notified the exposition of their intention to attend. These include: Charles Ginart, president, Oil Well Drilling Co., and director, Motembo Mining Co.; Rogelio Dominguez, vice president, Oil Well Drilling Co.; Miguel Leon, general manager, Motembo Mining Co.; Sergio Barriero, independent operator, and Emilio Rodriguez, Rodriguez Y. Larrea, all from Havana, Cuba; M. Metsch Ploesti, Roumania; Luis F. Herrera, Caracas, Venezuela; Werner Muller, Erkelenz, Rhineland, Germany, and S. H. Russell and Djevad Eyoub Tashman, Ankara, Turkey.

Skelly announced that the 1940 International Petroleum Exposition is assured of a complete sellout, with 96.3 percent of the available space already gone.

A safety contest, which is open to foremen and supervisors and to drivers of company-owned passenger automobiles and trucks, will culminate in a safety banquet during which contest winners, on the basis of their accident-free records, will be awarded gold engraved watches by the exposition. These competitions are open to workers throughout the world.

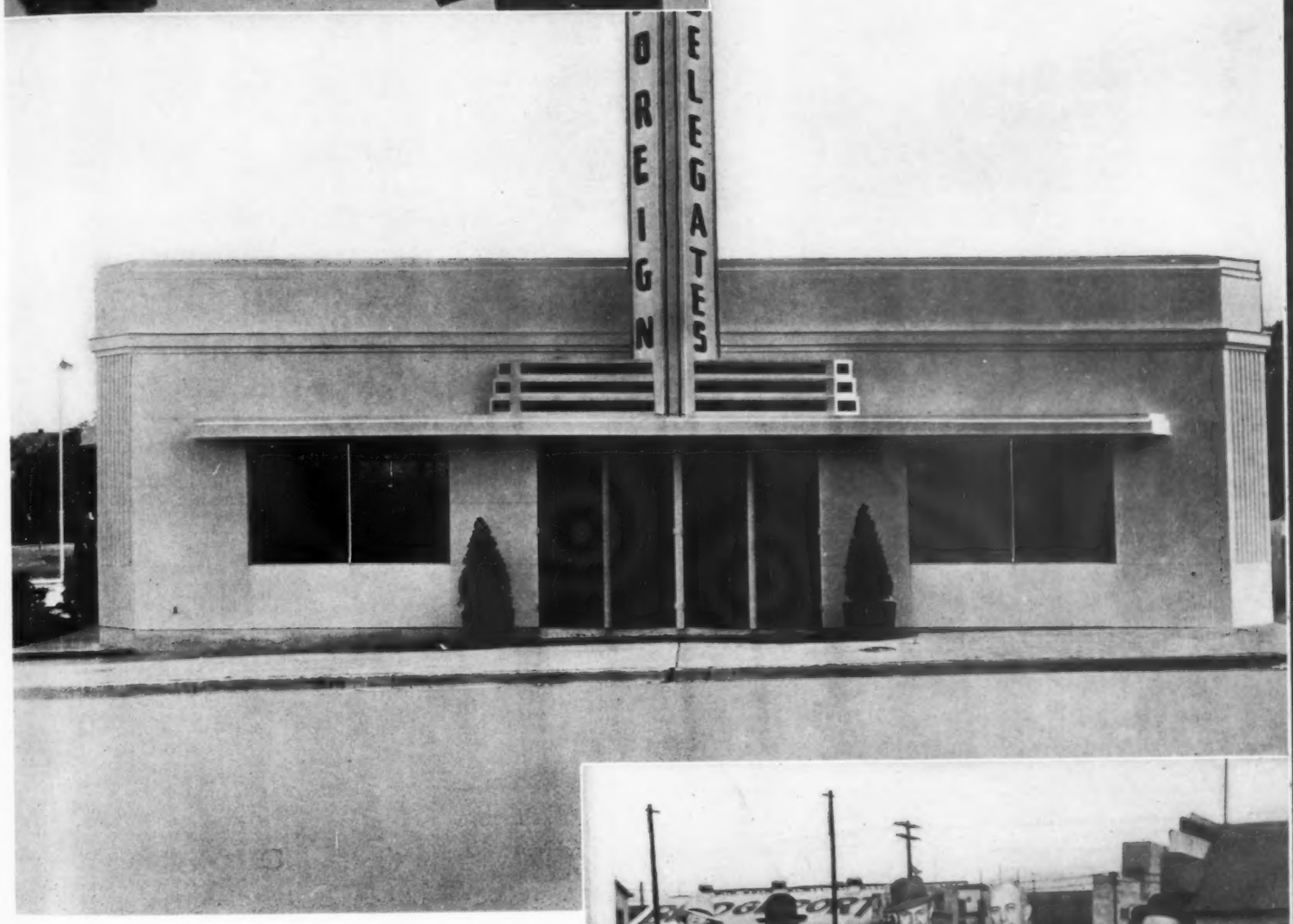
Of especial interest and value to the visiting international delegates to the 1940 International Petroleum Exposition will be the exhibits in the Hall of Science.

To encourage the attendance of geologists as well as to provide for exhibits pertaining to the finding and development of oil reserves, an exploration committee has been set up for the May 18 to 25, Tulsa oil show.

"Through cooperation between this committee and the scientific and technical committee, headed by Dr. Gustav Egloff, exhibits will be prepared to show exploration activities," M. G. Skelly pointed out.

International representation is included on the new exploration committee as one means

*Left, J. Mortorano and Dr. Carlos Perez de la Cova, representatives of the Venezuelan petroleum department at Tulsa arranging for exhibit, and right Barton A. Myers chairman of the international attendance committee of the Tulsa Show.*




to encourage geologists from other nations to attend the oil show, as well as to obtain an international viewpoint. P. E. Fitzgerald, research geologist for Dowell, Inc., Tulsa, is chairman of the committee.

"Most of the exhibit material to be arranged for by the committee will show the trend towards light, portable equipment on wheels, according to advance surveys," Chairman Fitzgerald announced.

*Above, headquarters for international delegates to the Tulsa exposition, and right, H. R. Powers with shovel and W. M. Bovaird with pick breaking ground for the building; in the back row are Nomads W. L. James, Fred E. Cooper, Shep Miers and H. M. Cosgrove.*

# WORLD OIL

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified. Figures in

## U. S. BARRELS

| | Feb. 1939 | Mar. 1939 | Apr. 1939 | May 1939 | June 1939 | July 1939 | Aug. 1939 | Sept. 1939 | Oct. 1939 | Nov. 1939 | Dec. 1939 | Preliminary Figures Jan. 1940 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| United States | 93,475,000 | 106,768,000 | 105,510,000 | 110,541,000 | 104,607,000 | 110,937,000 | 80,865,000 | 108,168,000 | 114,197,800 | 111,887,000 | 114,808,500 | 110,000,000 |
| Soviet Union[4] | 17,500,000 | 18,000,000 | 18,100,000 | 18,500,000 | 18,700,000 | 18,200,000 | 18,100,000 | 18,000,000 | 18,406,932[1] | 17,813,160[1] | 18,406,932[1] | 18,406,932 |
| Venezuela | 14,899,459 | 15,646,415 | 16,980,646 | 17,676,580 | 16,430,625 | 18,015,249 | 18,743,714 | 18,652,354 | 17,434,307 | 16,681,881 | 16,050,535 | 17,492,153 |
| Iran[5] | 4,978,350 | 6,992,667 | 7,237,755 | 6,801,192 | 6,341,652 | 6,637,503[1] | 6,637,503[1] | 6,423,390[1] | 6,637,503[1] | 6,423,390[1] | 6,637,503[1] | 6,637,503 |
| Netherland India: Sumatra | 3,113,863 | 3,393,286 | 3,401,503 | 3,602,543 | 3,498,094 | 3,557,020 | 3,550,123 | 3,502,437 | 3,600,371 | 3,427,490 | 3,629,655 | 3,516,669 |
| Borneo | 1,049,439 | 1,144,647 | 1,113,474 | 1,173,509 | 1,154,341 | 1,156,942 | 1,111,810 | 865,693 | 995,207 | 1,068,349 | 1,086,713 | 1,107,134 |
| Java[9] | 527,836 | 550,097 | 509,355 | 530,273 | 514,565 | 565,181 | 559,096 | 511,355 | 556,658 | 549,926 | 633,136 | 555,673 |
| Ceram | 57,896 | 67,440 | 82,914 | 89,975 | 77,305 | 73,962 | 71,767 | 68,065 | 64,292 | 62,340 | 60,550 | 70,122 |
| Roumania | 3,665,559 | 3,973,053 | 3,743,881 | 3,840,413 | 3,684,366 | 3,902,208 | 3,945,625 | 3,795,308 | 3,842,567 | 3,743,041 | 3,842,154 | 3,901,040 |
| Mexico[13] | 1,960,000 | 3,118,021 | 3,140,120 | 2,945,000 | 3,100,000 | 3,245,000 | 3,700,000[1] | 4,050,000 | 4,500,000 | 3,700,000 | 3,500,000 | 3,348,682 |
| Iraq | 1,961,152 | 2,699,272 | 2,608,235 | 2,663,827 | 2,721,992 | 2,807,402 | 2,615,129[1] | 2,530,770[1] | 2,615,129[1] | 2,530,770[1] | 2,615,129[1] | 2,615,129 |
| Colombia | 1,633,621 | 1,818,765 | 1,826,928 | 1,899,735 | 1,851,716 | 1,798,271 | 1,950,966 | 1,894,941 | 1,860,620 | 1,918,891 | 1,871,594 | 1,871,594 |
| Trinidad | 1,499,197 | 1,630,789 | 1,569,298 | 1,645,040 | 1,575,321 | 1,620,564 | 1,636,645[1] | 1,583,850[1] | 1,636,645[1] | 1,583,850[1] | 1,636,645[1] | 1,636,645 |
| Argentine | 1,431,339 | 1,554,957 | 1,507,159 | 1,559,568 | 1,533,250 | 1,508,738 | 1,495,806 | 1,542,755 | 1,632,997 | 1,621,927 | 1,691,123 | 1,580,814 |
| Peru[3] | 1,103,878 | 1,210,288 | 1,151,193 | 1,078,426 | 1,051,265 | 1,100,000[1] | 1,100,000[1] | 1,116,810[1] | 1,154,037[1] | 1,116,810[1] | 1,154,037[1] | 1,154,037 |
| Bahrein[6] | 610,766 | 658,822 | 629,336 | 626,009 | 628,812 | 671,892 | 698,714 | 647,595 | 571,673 | 563,985 | 645,575[1] | 645,575 |
| Burma[7] | 424,277 | 698,103 | 581,633 | 696,936 | 665 942 | 650,828 | 696,317 | 685,756 | 647,311[1] | 626,430[1] | 647,311[1] | 647,311 |
| Canada[1] | 358,176 | 385,273 | 559,368 | 713,947 | 821,308 | 899,169 | 795,844 | 720,866 | 816,257 | 731,209 | 502,920 | 665,632 |
| Brunei[8] | 445,383 | 492,374 | 466,328 | 486,815 | 464,271 | 490,318 | 488,777[1] | 473,010[1] | 488,777[1] | 473,010[1] | 488,711[1] | 488,777 |
| Great Germany: Old Reich[14] | 332,965 | 396,181 | 373,126 | 407,028 | 373,510 | 391,098 | 381,114[1] | 368,820[1] | 381,114[1] | 368,820[1] | 381,114[1] | 381,114 |
| Ostmark[15] | 46,701 | 43,293 | 54,375 | 64,840 | 74,726 | 85,131 | 58,869[1] | 56,970[1] | 58,869[1] | 56,970[1] | 58,869[1] | 58,869 |
| Slovakia and Moravia | 9,000 | 10,000 | 9,000 | 10,000 | 9,000 | 11,000 | 11,000[1] | 9,810[1] | 10,137[1] | 9,810[1] | 10,137[1] | 10,137 |
| Poland | 298,259 | 333,618 | 326,436[1] | 333,800[1] | 318,000[1] | 330,000[1] | 330,000[1] | 320,370[1] | 331,049[1] | 320,370[1] | 331,049[1] | 331,049 |
| Japan[12] | 218,612 | 222,386 | 218,612 | 221,129 | 221,128 | 222,072 | 210,105 | 222,513 | 223,016 | 224,494 | 223,960[A] | 225,308 |
| British India[11] | 213,185 | 236,042 | 105,477 | 127,700 | 137,070 | 175,932 | 200,036 | 212,322 | 188,666[1] | 182,580[1] | 188,666[1] | 188,666 |
| Ecuador | 171,634 | 181,938 | 175,896 | 193,353 | 193,710 | 206,868 | 204,115 | 193,720 | 193,382 | 196,808 | 205,138 | 204,509 |
| Saudi Arabia | 170,865 | 215,270 | 234,742 | 281,325 | 302,932 | 342,558 | 350,000 | 538,136 | 512,590 | 313,757 | 437,020 | 491,663 |
| Sarawak[13] | 100,358 | 115,990 | 110,982 | 112,572 | 104,224 | 107,961 | 112,716[1] | 109,080[1] | 112,716[1] | 109,080[1] | 112,716[1] | 112,716 |
| Egypt[13] | 301,102 | 330,445 | 328,376 | 368,081 | 425,231 | 436,519 | 440,678 | 362,880 | 420,519 | 434,174 | 385,795[1] | 385,733 |
| Italian Empire: Albania[16] | 67,914 | 125,440 | 244,576 | 81,839 | 79,931 | 140,025 | 89,000[1] | 114,540[1] | 118,358[1] | 114,540[1] | 118,358[1] | 118,358 |
| Italy | 8,090 | 8,324 | 7,792 | 7,253 | 7,181 | 6,843 | 7,600[1] | 7,736[1] | 7,750[1] | 7,500[1] | 7,750[1] | 7,750 |
| France | 40,000 | 42,000 | 41,000 | 42,000 | 41,000 | 42,000 | 42,000 | 42,653 | 42,470 | 41,160 | 42,532 | 42,532 |
| Hungary | 49,578 | 67,261 | 67,000[1] | 70,000[1] | 67,000[1] | 70,000[1] | 70,000[1] | 65,210[1] | 65,317[1] | 63,210[1] | 65,317 | 65,317 |
| Bolivia | 7,000 | 8,700 | 8,500 | 8,700 | 8,500 | 8,700 | 8,700 | 7,893 | 8,556 | 8,280 | 8,556 | 8,556 |
| Other Countries[17] | 35,000 | 50,000 | 48,000 | 50,000 | 48,000 | 50,700 | 50,700 | 50,000 | 49,073 | 47,490 | 49,073 | 49,073 |
| WORLD TOTAL | 152,772,775 | 173,159,157 | 173,073,016 | 179,405,408 | 171,832,968 | 180,464,654 | 151,329,469 | 177,915,608 | 184,382,665 | 179,022,502 | 182,534,773 | 179,022,714 |

[A] Estimated official sources.
[1] Estimated W. P.
[2] Includes natural gasoline (naphtha) production.
[3] International Petroleum Company and Lobitos Oilfields, Ltd., figures combined.
[4] Russian Saghalin included with U.S.S.R.
[5] Anglo-Iranian Oil Company, Ltd., figures revised —fuel oil returned to the ground has been deducted.
[6] Bahrein Petroleum Company, Ltd., figures.
[7] Does not include Assam or Punjab, which are listed together under British India.
[8] British Malayan Petroleum Company, Ltd., figures.
[9] Includes Madura.

### Daily Averages in Barrels

| | Jan. 1940 | Jan. 1939 |
|---|---|---|
| United States | 3,548,387 | 3,306,129 |
| Soviet Union | 593,772 | 548,387 |
| Venezuela | 564,263 | 531,914 |
| Iran | 214,113 | 206,545 |
| Netherland India: Sumatra | 113,439 | 100,935 |
| Borneo | 35,714 | 35,986 |
| Java | 17,925 | 17,267 |
| Ceram | 2,262 | 1,587 |
| Roumania | 125,840 | 127,537 |
| Mexico | 108,022 | 79,677 |
| Iraq | 84,359 | 78,139 |
| Colombia | 60,374 | 55,179 |
| Trinidad | 52,795 | 53,303 |
| Argentine | 50,994 | 49,469 |
| Peru | 37,227 | 40,360 |
| Bahrein | 20,825 | 20,902 |
| Burma | 20,881 | 19,382 |
| Canada | 21,472 | 17,198 |
| Brunei | 15,767 | 16,041 |
| Great Germany: Old Reich | 12,294 | 10,729 |
| Ostmark | 1,899 | 1,084 |
| Slovakia and Moravia | 327 | 338 |
| Poland | 10,679 | 10,486 |
| Japan | 7,268 | 7,254 |
| British India | 6,086 | 8,184 |
| Ecuador | 6,597 | 6,308 |
| Saudi Arabia | 15,860 | 5,018 |
| Sarawak | 3,636 | 3,836 |
| Egypt | 12,443 | 9,966 |
| Italian Empire: Albania | 3,818 | 3,200 |
| Italy | 250 | 250 |
| France | 1,372 | 1,354 |
| Hungary | 2,107 | 1,589 |
| Bolivia | 276 | 283 |
| Other Countries | 1,583 | 1,612 |
| WORLD TOTAL | 5,774,926 | 5,377,452 |

### Official Crude Oil Production Figures for 1933 to 1939 (Revised) in Barrels

| | 1939 | 1938 | 1937 | 1936 | 1935 | 1934 | 1933 |
|---|---|---|---|---|---|---|---|
| United States | 1,264,256,000 | 1,214,355,000 | 1,279,160,000 | 1,098,516,000 | 996,596,000 | 908,065,000 | 905,656,000 |
| Soviet Union | 216,727,024 | 206,192,000 | 201,856,661 | 199,635,921 | 184,008,033 | 175,635,783 | 155,596,429 |
| Venezuela | 205,956,300 | 188,429,050 | 187,675,477 | 155,270,840 | 148,809,057 | 136,098,681 | 117,113,940 |
| Iran | 78,151,332 | 78,320,840 | 78,109,001 | 62,977,950 | 57,520,488 | 57,902,092 | 54,440,075 |
| Netherland India: Sumatra | 41,405,392 | 34,538,128 | 33,451,511 | 30,469,428 | 28,004,595 | 26,336,011 | 22,345,172 |
| Borneo | 13,035,694 | 12,812,383 | 12,960,072 | 13,068,910 | 13,529,185 | 14,335,543 | 15,003,175 |
| Java | 6,542,775 | 6,955,283 | 7,152,931 | 3,618,293 | 3,462,440 | 3,778,920 | 3,600,816 |
| Ceram | 825,706 | 607,622 | 537,436 | 375,823 | 311,872 | 273,698 | 285,335 |
| Roumania | 45,931,846 | 48,366,000 | 52,395,725 | 63,532,846 | 61,270,072 | 61,849,306 | 53,919,700 |
| Mexico | 39,428,141 | 38,505,824 | 46,455,687 | 41,027,915 | 40,240,563 | 38,171,946 | 34,000,830 |
| Iraq | 30,791,132 | 32,404,000 | 30,603,660 | 29,913,150 | 27,410,983 | 7,639,849 | 1,094,915 |
| Colombia | 22,036,613 | 21,581,588 | 20,297,543 | 18,756,110 | 17,597,655 | 17,337,900 | 13,156,126 |
| Trinidad | 19,270,256 | 17,736,176 | 15,502,989 | 13,237,030 | 11,671,224 | 10,894,363 | 9,561,353 |
| Argentina | 18,613,167 | 17,076,223 | 16,354,717 | 15,457,960 | 14,297,025 | 14,021,901 | 13,690,556 |
| Peru | 13,587,906 | 15,908,279 | 17,459,112 | 17,593,069 | 17,056,555 | 16,314,381 | 13,257,310 |
| Bahrein | 7,601,167 | 8,297,998 | 7,762,264 | 4,644,635 | 1,264,807 | 285,072 | 31,377 |
| Burma | 7,621,707 | 7,499,498 | 7,847,553 | 7,587,718 | 7,181,113 | 7,278,859 | 7,114,311 |
| Canada | 7,837,503 | 6,965,457 | 2,996,033 | 1,507,931 | 1,447,204 | 1,410,895 | 1,145,333 |
| Brunei | 5,755,164 | 5,387,214 | 4,397,038 | 3,296,938 | 3,302,905 | 2,705,350 | 2,035,656 |
| Great Germany: Old Reich | 4,487,491 | 3,850,044 | 3,148,300 | 3,076,858 | 2,967,438 | 2,204,402 | 1,656,602 |
| Ostmark | 693,247 | 370,038 | 221,266 | 50,092 | 44,347 | 27,965 | 5,765 |
| Slovakia and Moravia | 119,380 | 132,005 | 123,474 | 126,603 | 136,580 | 177,797 | 121,695 |
| Poland | 3,898,044 | 3,828,438 | 3,799,862 | 3,869,575 | 3,901,881 | 4,011,336 | 4,174,079 |
| Japan | 2,652,930 | 2,511,184 | 2,487,841 | 2,403,072 | 2,294,878 | 1,872,837 | 1,504,412 |
| British India | 2,221,406 | 2,330,209 | 2,161,653 | 1,978,329 | 2,037,810 | 1,921,863 | 1,628,803 |
| Ecuador | 2,312,118 | 2,257,278 | 2,161,436 | 1,942,467 | 1,731,785 | 1,636,619 | 1,619,902 |
| Saudi Arabia | 3,854,800 | 495,135 | 64,968 | 19,777 | Nil | Nil | Nil |
| Sarawak | 1,327,327 | 1,624,882 | 1,655,565 | 1,547,882 | 1,776,593 | 1,942,591 | 2,206,815 |
| Egypt | 4,541,746 | 1,561,231 | 1,163,267 | 1,262,666 | 1,255,151 | 1,527,252 | 1,653,535 |
| Italian Empire: Albania | 1,393,727 | 437,597 | 380,292 | 219,693 | 41,218 | 17,500 | 11,437 |
| Italy | 91,330 | 106,083 | 112,700 | 129,653 | 128,615 | 162,449 | 213,534 |
| France | 500,815 | 516,240 | 507,067 | 534,063 | 529,664 | 700,000 | 786,366 |
| Hungary | 769,092 | 330,829 | 13,910 | 100 | Nil | Nil | Nil |
| Bolivia | 100,885 | 106,620 | 123,123 | 104,746 | 163,295 | 157,875 | 111,973 |
| Other Countries | 578,036 | 243,000 | 70,000 | 37,100 | 32,300 | 64,000 | 54,100 |
| WORLD TOTAL | 2,029,917,199 | 1,982,639,376 | 2,041,170,134 | 1,797,791,150 | 1,652,023,331 | 1,516,760,036 | 1,438,797,443 |

# PRODUCTION

Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries

## METRIC TONS

| | Feb. 1939 | Mar. 1939 | Apr. 1939 | May 1939 | June 1939 | July 1939 | Aug. 1939 | Sept. 1939 | Oct. 1939 | Nov. 1939 | Dec. 1939 | Preliminary Figures Jan., 1940 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| United States | 12,647,138 | 14,445,677 | 14,275,470 | 14,956,000 | 14,153,000 | 15,009,700 | 10,941,000 | 14,635,096 | 15,450,953 | 15,138,276 | 15,533,757 | 14,882,965 |
| Soviet Union[4] | 2,400,000 | 2,469,000 | 2,480,000 | 2,536,000 | 2,590,000 | 2,500,000 | 2,480,000 | 2,300,000 | 2,508,024[1] | 2,427,120[1] | 2,508,024[1] | 2,508,024 |
| Venezuela | 2,201,782 | 2,323,150 | 2,521,254 | 2,624,585 | 2,439,598 | 2,674,870 | 2,783,031 | 2,769,466 | 2,586,268 | 2,476,894 | 2,586,268 | 2,566,800 |
| Iran[5] | 660,400 | 927,608 | 960,120 | 902,208 | 841,248 | 880,493[1] | 880,493[1] | 852,090[1] | 880,493[1] | 852,090[1] | 880,493[1] | 880,493 |
| Netherland India: Sumatra | 398,651 | 434,424 | 435,476 | 461,214 | 447,842 | 455,386 | 454,503 | 448,398 | 460,936 | 438,803 | 464,685 | 451,856 |
| Borneo | 134,354 | 146,543 | 142,552 | 150,238 | 147,784 | 148,117 | 142,339 | 110,830 | 127,411 | 136,775 | 139,126 | 142,321 |
| Java[6] | 67,576 | 70,426 | 65,210 | 67,888 | 65,877 | 72,357 | 71,578 | 65,466[1] | 71,266 | 70,404 | 81,057 | 71,393 |
| Ceram | 7,412 | 8,634 | 10,615 | 11,519 | 9,897 | 9,469 | 9,188 | 8,842 | 8,231 | 7,981 | 7,752 | 8,990 |
| Roumania | 497,025 | 538,719 | 507,645 | 520,734 | 499,575 | 529,113 | 535,000 | 514,618 | 521,026 | 507,531 | 520,970 | 528,953 |
| Mexico[7] | 287,813 | 457,859 | 461,104 | 432,452 | 455,212 | 476,505 | 543,316 | 594,713 | 660,973 | 543,318 | 513,950 | 492,094 |
| Iraq | 262,151 | 360,817 | 348,648 | 356,079 | 363,854 | 375,271 | 349,556[1] | 338,280[1] | 349,556[1] | 338,280[1] | 349,556[1] | 349,556 |
| Colombia | 227,841 | 253,663 | 254,802 | 264,956 | 258,258 | 247,017 | 272,101 | 264,287 | 257,920 | 267,627 | 260,524 | 260,524 |
| Trinidad | 210,857 | 229,365 | 220,717 | 231,370 | 221,564 | 227,927 | 230,206[1] | 222,780[1] | 230,206[1] | 222,780[1] | 230,206[1] | 230,206 |
| Argentine | 203,894 | 221,503 | 214,695 | 222,160 | 218,411 | 214,919 | 213,077 | 219,765 | 232,620 | 231,043 | 240,900 | 222,184 |
| Peru[1] | 146,286 | 159,774 | 151,973 | 142,367 | 138,782 | 146,000[1] | 146,000[1] | 147,810[1] | 152,737[1] | 147,810[1] | 152,737[1] | 152,737 |
| Bahrein[8] | 83,180 | 89,811 | 85,920 | 85,353 | 85,665 | 91,551 | 95,348 | 87,030 | 78,012 | 76,963 | 87,885[1] | 87,885 |
| Burma[7] | 58,602 | 96,423 | 80,336 | 96,261 | 91,980 | 89,893 | 96,176 | 94,717 | 89,404[1] | 86,520[1] | 89,404[1] | 89,404 |
| Canada[3] | 45,581 | 49,029 | 71,184 | 90,856 | 104,518 | 114,427 | 101,278 | 91,736 | 103,875 | 93,052 | 64,001 | 84,692 |
| Brunei[9] | 59,416 | 65,684 | 62,209 | 64,943 | 61,935 | 65,410 | 65,193[1] | 63,090[1] | 65,193[1] | 63,090[1] | 65,193[1] | 65,193 |
| Great Germany: Old Reich[10] | 47,614 | 56,654 | 53,357 | 58,205 | 53,412 | 55,927 | 58,300[1] | 53,190[1] | 54,963[1] | 53,190[1] | 54,963[1] | 54,963 |
| Ostmark[10] | 6,962 | 6,454 | 8,106 | 9,666 | 11,289 | 12,691 | 13,000[1] | 9,030[1] | 9,331[1] | 9,030[1] | 9,331[1] | 9,331 |
| Slovakia and Moravia | 1,500[1] | 1,500[1] | 1,400[1] | 1,500[1] | 1,400[1] | 1,600[1] | 1,600[1] | 1,550[1] | 1,519[1] | 1,470[1] | 1,519[1] | 1,519 |
| Poland | 40,202 | 44,968 | 44,000[1] | 45,000[1] | 41,000[1] | 45,000[1] | 45,000[1] | 42,960[1] | 44,392[1] | 42,960[1] | 44,392[1] | 44,392 |
| Japan[9] | 31,094 | 31,631 | 31,095 | 31,455 | 31,454 | 31,544 | 31,721 | 31,651 | 31,723 | 31,933 | 31,857[A] | 32,178 |
| British India[11] | 29,445 | 32,602 | 14,568 | 17,638 | 18,932 | 24,300 | 27,629 | 29,326 | 26,040[1] | 25,200[1] | 26,040[1] | 26,404 |
| Ecuador | 22,628 | 23,986 | 23,190 | 25,491 | 25,539 | 27,272 | 26,910 | 25,540 | 25,495 | 25,947 | 27,045 | 26,962 |
| Saudi Arabia | 23,146 | 29,161 | 31,799 | 38,110 | 41,037 | 46,404 | 47,500 | 72,899 | 72,899 | 42,503 | 59,201 | 66,604 |
| Sarawak[12] | 13,848 | 14,823 | 14,183 | 14,386 | 13,329 | 13,797 | 14,539[1] | 14,070[1] | 14,539[1] | 14,070[1] | 14,539[1] | 14,539 |
| Egypt[13] | 43,002 | 47,193 | 46,897 | 52,568 | 60,730 | 62,342 | 62,936 | 51,810 | 60,057 | 62,150 | 55,087[1] | 55,335 |
| Italian Empire: Albania[14] | 10,179 | 18,801 | 36,657 | 12,266 | 11,980 | 20,987 | 13,000[1] | 17,100[1] | 17,670[1] | 17,100[1] | 17,670[1] | 17,670 |
| Italy | 1,005 | 1,034 | 968 | 901 | 892 | 850 | 950[1] | 961[1] | 961[1] | 930[1] | 961[1] | 961 |
| France | 5,500[1] | 6,000[1] | 5,700[1] | 6,000[1] | 5,700[1] | 6,000[1] | 6,000[1] | 5,760[1] | 5,952[1] | 5,760[1] | 5,952[1] | 5,952 |
| Hungary | 6,670 | 9,049 | 9,000[1] | 9,500[1] | 9,000[1] | 9,500[1] | 9,500[1] | 8,490[1] | 8,773[1] | 8,490[1] | 8,773[1] | 8,773 |
| Bolivia | 900[1] | 1,000[1] | 1,000[1] | 1,000[1] | 1,000[1] | 1,000[1] | 1,000[1] | 960[1] | 992[1] | 960[1] | 992[1] | 992 |
| Other Countries[17] | 6,000[1] | 7,000[1] | 6,700[1] | 7,000[1] | 6,700[1] | 7,100[1] | 7,100[1] | 7,000[1] | 6,975[1] | 6,750[1] | 6,975[1] | 6,975 |
| WORLD TOTAL | 20,895,604 | 23,679,965 | 23,678,550 | 24,547,815 | 23,528,394 | 24,694,739 | 20,776,068 | 24,201,311 | 25,217,385 | 24,474,800 | 25,141,785 | 24,449,456 |

[9] Japanese Saghalin, Taiwan (Formosa) and Hokkaido included with Japan.
[11] Excluding Burma.
[12] Sarawak Oilfields, Ltd., figures.
[13] Anglo-Egyptian Oilfields, Ltd., figures.
[14] Prussia, Thuringia and Baden.
[15] Formerly known as Austria.
[16] Italian imports of Albanian crude oil.
[17] Estimate representing Morocco, Cuba, New Zealand, Barbados, Greece, Algeria, Yugoslavia, Australia, Great Britain, Kuwait and China.
[18] Official Figures—Petroleos Mexicanos.
[A] Estimated Official Sources

### Daily Averages in Metric Tons

| | Jan. 1940 | Jan. 1939 |
|---|---|---|
| United States | 480,095 | 447,318 |
| Soviet Union | 80,904 | 75,225 |
| Venezuela | 82,800 | 78,651 |
| Iran | 28,403 | 27,399 |
| Netherland India: Sumatra | 14,576 | 13,548 |
| Borneo | 4,591 | 4,830 |
| Java | 2,303 | 2,317 |
| Ceram | 290 | 213 |
| Roumania | 17,063 | 17,293 |
| Mexico | 15,899 | 11,838 |
| Iraq | 11,276 | 10,445 |
| Colombia | 8,404 | 7,695 |
| Trinidad | 7,426 | 7,501 |
| Argentine | 7,167 | 7,046 |
| Peru | 4,927 | 5,363 |
| Bahrein | 2,835 | 2,847 |
| Burma | 2,884 | 2,677 |
| Canada | 2,732 | 2,188 |
| Brunei | 2,103 | 2,140 |
| Great Germany: Old Reich | 1,773 | 1,534 |
| Ostmark | 301 | 161 |
| Slovakia and Moravia | 49 | 50 |
| Poland | 1,432 | 1,387 |
| Japan | 1,038 | 1,032 |
| British India | 840 | 1,130 |
| Ecuador | 869 | 896 |
| Saudi Arabia | 2,148 | 679 |
| Sarawak | 469 | 490 |
| Egypt | 1,785 | 1,419 |
| Italian Empire: Albania | 570 | 479 |
| Italy | 31 | 30 |
| France | 192 | 190 |
| Hungary | 283 | 213 |
| Bolivia | 32 | 35 |
| Other Countries | 225 | 225 |
| WORLD TOTAL | 788,692 | 736,461 |

### Official Crude Oil Production Figures for 1933 to 1939 (Revised) in Metric Tons

| | 1939 | 1938 | 1937 | 1936 | 1935 | 1934 | 1933 |
|---|---|---|---|---|---|---|---|
| United States | 171,053,443 | 164,346,325 | 172,822,797 | 148,707,864 | 134,912,143 | 122,913,903 | 122,601,191 |
| Soviet Union | 29,530,168 | 28,859,000 | 27,867,025‡ | 27,384,900 | 25,241,100 | 24,092,700 | 21,330,100 |
| Venezuela | 30,580,000 | 27,845,286 | 27,733,926 | 22,945,299 | 21,990,373 | 20,112,115 | 17,293,193 |
| Iran | 10,367,112 | 10,358,495 | 10,330,480 | 8,329,289 | 7,607,500 | 7,657,970 | 7,200,093 |
| Netherland India: Sumatra | 5,320,319 | 4,662,836 | 4,490,137 | 4,114,710 | 3,759,006 | 3,535,035 | 2,999,352 |
| Borneo | 1,675,810 | 1,719,783 | 1,739,607 | 1,773,545 | 1,815,998 | 1,924,234 | 2,013,849 |
| Java | 840,957 | 933,595 | 960,125 | 499,097 | 464,757 | 510,320 | 483,331 |
| Ceram | 106,144 | 81,560 | 72,139 | 50,446 | 41,862 | 36,738 | 38,300 |
| Roumania | 6,228,047 | 6,603,000 | 7,153,000 | 8,704,000 | 8,394,000 | 8,473,355 | 7,387,000 |
| Mexico | 5,794,215 | 5,716,423 | 6,896,657 | 6,090,842 | 5,973,955 | 5,666,857 | 5,049,109 |
| Iraq | 4,115,845 | 4,345,000 | 4,126,185 | 4,079,066 | 3,724,231 | 1,048,108 | 147,943 |
| Colombia | 3,067,568 | 3,007,935 | 2,844,251 | 2,614,092 | 2,452,635 | 2,416,432 | 1,833,606 |
| Trinidad | 2,710,515 | 2,472,943 | 2,181,676 | 1,862,796 | 1,642,446 | 1,533,122 | 1,345,532 |
| Argentina | 2,651,448 | 2,432,857 | 2,330,063 | 2,202,304 | 2,036,903 | 1,997,706 | 1,950,499 |
| Peru | 1,798,557 | 9,099,885 | 2,313,691 | 2,331,454 | 2,260,903 | 2,161,990 | 1,756,867 |
| Bahrein | 1,034,982 | 1,130,734 | 1,058,557 | 635,555 | 173,072 | 39,008 | 4,293 |
| Burma | 1,052,708 | 1,039,960 | 1,083,391 | 1,047,593 | 991,456 | 1,004,951 | 982,233 |
| Canada | 997,391 | 879,921 | 378,478 | 190,495 | 182,820 | 178,233 | 144,686 |
| Brunei | 767,700 | 707,123 | 576,545 | 470,991 | 471,842 | 386,478 | 290,808 |
| Great Germany: Old Reich | 647,337 | 552,074 | 453,451 | 444,600 | 427,400 | 317,500 | 238,600 |
| Ostmark | 109,904 | 63,468 | 33,010 | 7,473 | 6,616 | 4,172 | 860 |
| Slovakia and Moravia | 18,103 | 19,282 | 18,036 | 18,665 | 19,946 | 25,971 | 17,776 |
| Poland | 522,874 | 504,678 | 501,301 | 510,630 | 614,760 | 529,200 | 550,670 |
| Japan | 379,161 | 356,328 | 341,040 | 341,976 | 326,580 | 266,520 | 212,667 |
| British India | 306,765 | 322,125 | 298,450 | 273,137 | 281,072 | 265,341 | 224,879 |
| Ecuador | 306,824 | 319,877 | 306,326 | 275,293 | 245,434 | 231,947 | 229,578 |
| Saudi Arabia | 525,737 | 66,683 | 8,070 | 2,447 | Nil | Nil | Nil |
| Sarawak | 171,322 | 200,126 | 217,085 | 221,126 | 253,799 | 277,513 | 315,259 |
| Egypt | 648,780 | 223,058 | 166,298 | 177,491 | 176,436 | 214,671 | 232,437 |
| Italian Empire: Albania | 208,279 | 65,313 | 56,760 | 32,760 | 6,152 | 2,500 | 1,707 |
| Italy | 11,346 | 13,178 | 14,000 | 16,106 | 15,977 | 20,180 | 26,526 |
| France | 70,224 | 72,106 | 71,008 | 74,788 | 74,172 | 98,025 | 110,120 |
| Hungary | 103,364 | 42,798 | 13,910 | 13 | Nil | Nil | Nil |
| Bolivia | 11,904 | 13,262 | 15,487 | 13,197 | 20,540 | 19,858 | 14,085 |
| Other Countries | 82,300 | 34,080 | 10,000 | 5,300 | 4,600 | 9,100 | 7,700 |
| WORLD TOTAL | 283,817,153 | 279,111,097 | 279,482,962 | 246,449,340 | 226,610,486 | 207,971,753 | 197,034,849 |

# WORLD PETROLEUM ABSTRACTS

**Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox**

## GEOPHYSICS

**A Proposed Geophysical Method for Orienting Cores**—Victor Vacquier in GEOPHYSICS, Vol. 4 (1939), No. 4, pp. 292-299.

A new method of orienting cores is suggested, in which a fluid suspension of magnetic particles is made to solidify and adhere firmly to the formation at the bottom of the well. While the substance is still liquid, the magnetic particles line up in the direction of the earth's magnetic field so that upon solidifying a magnetized body is tightly cemented to the rock. The formation is then cooled and the top-most core carrying an inclusion of the polarized material is oriented by means of a magnetometer. When such a core is recovered there can be no doubt as to the fidelity of the result.

Various passible objections to the method are considered, but these apparently are not decisive.

**Correlating Gravity Maximum with Oil Structure in Ramsey Field**—J. F. Evans, in OIL & GAS JOURNAL, Vol. 38 (1939), No. 26, p. 37.

Geophysists have long been aware of a definite correlation between the location of gravity minima and those of salt dome regions in the Gulf Coast region. This is because there is a marked difference in the density of salt plugs and the density of the overlying shale.

Under the different structural conditions existing in the Mid-Continent area of Oklahoma and Kansas some question has been raised as to whether any relation might be found in that region between gravitational features and oil-producing structures. Here the density difference between the rock formations is generally small. However, in the particular case of the Ramsey field of Oklahoma a very definite correlation has been found between a measurable gravitational feature (a maximum) and a producing oil structure. In this case the gravity maximum presumably arises from the granite plug which is believed to be the core of the structure. The situation thus appears to be the reverse of salt plug conditions, where the salt provides the conditions for a gravitational minimum.

**Electrical Well Logging**—Houston Geological Society Study Group in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 23 (1939), No. 9, pp. 1287-1313.

This is a survey of the various cases to which electrical logging may be applied by means of a multiple electrode arrangement, with interpretations of electrical curves showing peculiar characteristics due to abnormal conditions.

As to the future of electrical logging, the authors observe that although a remarkable advancement has already been made in the technique of electrical logging, it has by no means reached the end of its possibilities. During the first few years of application, it established an undisputed reputation as an ideal tool for correlation. At the same time, considerable experience was gained in the interpretation of fluid content of the formations, leading to the use of several resistivity curves for this purpose, in order to eliminate the effect of invasion of porous formations by water from the drilling mud.

More recently, it has been found that a very close and exact relationship exists between the electrical resistivity and the potential production of a porous zone. Obviously the determination, in this manner, of the recoverable oil in a given field has great possibilities for future development.

The self-potential curve also offers possibilities of a wider application, in the use of several curves recorded under different conditions. While the single curve allows a ready distinction between porous and non-porous formations, two or more curves, recorded at different pressures, provide a means of determining, in place, the permeability of the formation.

For example, if the differential pressure (hydrostatic head minus formation pressure) is increased by applying additional pressure on the mud column; the electro-filtration will increase in front of the more permeable formations, and if curves of self-potential are made at different pressures, it will be seen that the self-potential differential curve is very similar to the permeability curve. In practice, this differential self-potential curve is a measure of the permeability of the undisturbed formations, with respect to the fluids which they contain. Consequently, the permeability determined in this manner is a better guide to the behavior of a given formation under production or flooding conditions, than is the permeability determined on a core, for example. For the same reason, electrical permeability and core analysis may not necessarily agree.

## DRILLING

**Radial Filtration of Drilling Muds**—Milton Williams, in PETROLEUM TECHNOLOGY, Vol. 2 (1939), No. 4, Technical Publication, No. 1112, 13 pages.

It is generally recognized that fluid is lost from rotary drilling muds to permeable strata during normal drilling operations. but that this fluid is the filtrate from the mud, rather than the mud itself, has been shown by various workers.

The presence of this filtrate in oil-bearing or gas-bearing strata is undesirable and harmful. The decreased permeability of the stratum to oil effected by the presence of water has been pointed out by several investigators, and since, in the production of the reservoir fluid, the greatest pressure drop occurs immediately adjacent to the borehole, it follows that infiltered water is particularly objectionable in this region. Again, this filtrate tends to make electrical logs less reliable, since oil in the proximity of the borehole is probably flushed out to an appreciable extent by the water. Observation of side wall cores may be misleading for the same reason. Drill-stem tests in low-pressure areas may be of doubtful value where no oil is recovered, unless sufficient time is allowed for production of water lost from the mud. The infiltered water may hinder drilling operations by softening shales and causing sloughing; the "tight hole" occasioned by excessive deposition of filter cake in the hole is a common occurrence. The filter cake remaining on the face of the producing formation may itself sometimes be detrimental to production.

In view of these implications of the importance of filtration of mud, an investigation was undertaken to determine the factors involved in the infiltration process, and to correlate these in such a manner that the values obtained in routine filter tests employing a conventional filter of the "wall-building tester" type, together with data on size of hole, drill pipe, and rate of mud circulation, could be used to estimate water loss and distance of penetration of the filtrate into strata.

For counteracting these undesirable conditions there is only one thing to do, and that is to control the nature of the mud so that it will give up as little water as possible to the surrounding sands. This means that the mud should have a small filtration rate. The mud engineers are acquainted with simple laboratory tests for filtration rates, but these methods are deficient in that they do not simulate the circumstances that exist during drilling operations, where the hydraulic conditions are different and where the mud is in rapid circulation.

Proceeding from that standpoint the author has devised a filter test with a stream of mud flowing through the filter under pressure. This gives a "filter constant" corresponding to different depths of hole. From this data the filtration rate, and the distance to which the water will penetrate in a given time at a given zone, may be computed. Such tests will give a general indication of whether the mud should receive more dispersing agents and particles of colloidal dimensions to lower its filterability.

**Detection of Radioactive Cement in Cased Wells**—Lynn G. Howell and Alex Frasch, in PETROLEUM TECHNOLOGY, Vol. 2 (1939), No. 4, Technical Publication No. 1113; 8 pages.

This paper describes an interesting use of the Geiger-Miller tube. This apparatus is a sealed section of pipe which contains an apparatus for registering the radioactivity (gamma rays) of rocks in its vicinity. By lowering the tube into a well and then raising it up again a record can be made of the radioactivities of the different strata penetrated by the hole. The record thus obtained shows a remarkable correlation with the electrical (Schlumberger) logs. In general, sands show up as radioactive "lows" and the shales as radioactive "highs". In contrast to electrical logging which can only be made in open (uncased) holes, the gamma ray surveys can be made in the presence as well as in the absence of casing.

The Geiger-Miller gamma ray outfit has now been applied to the verification of cement jobs. For this purpose the cement poured into the hole is first mixed with some powdered, radioactive mineral; in the work here reported the mineral

used was carnotite which contained around 10 percent of uranium oxide; carnotite is a mineral from which radium is commercially produced. By first making a gamma ray survey of the hole before cementing and again after cementing the height to which the cement had risen could be determined within a few feet. Such tests have shown some surprising facts. Thus, in two wells containing the same amount of casing and of cement, there was a difference of about 600 feet in the height of the cement in the two wells.

Another interesting employment is to investigate the cement used in the so-called squeeze job. In one test it was found that the cement had moved up the casing about 60 to 70 feet from the perforated zone. In a second test it was found that the cement had remained near the zone of perforation. Other obvious applications of the method are detection of radioactivated acidizing agents, plugging agents, gels, etc.

This method of investigating cement jobs is more flexible than the temperature method in that it is not necessary to make the survey while the cement is still setting up; also, the circulation of mud has no disturbing effect; if need be the concentration of the ore can be made great enough to give a great enough change in gamma ray intensity for any case.

**Drilling-Time Data in Rotary Practice**—I. C. Hiestand and P. B. Nichols, with Interpretation of Data by T. C. Hiestand, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 23 (1939), No. 12, pp. 1820-1834.

By drilling-time is meant the rate at which a rotary bit penetrates the underlying strata. With the same constant weight on the bit and the same constant rate of revolution of the rotary table, the time required by the bit to penetrate a given stratum is a function of the hardness or resistance of the latter, and the hardness is generally in proportion to the porosity of the rock.

Accurate observation of drilling-time is therefore a valuable means of ascertaining the character of the strata penetrated; oil, so far as it is not found in caverns or cavities, is contained in porous beds, and it is self evident that every bed of marked porosity should be examined, by coring or test, to see whether it is a "pay zone".

Various crude methods of recording drilling-time have long been used but such rough and ready measurements have not as a rule yielded much valuable information. When drilling time is recorded manually, the human element enters largely into the accuracy of the data.

A noteworthy advance in this technique was made several years ago by P. B. Nichols, who invented an instrument called a geolograph which is connected with the drill pipe above the derrick floor in such a way that any vertical movement of the drill pipe is automatically recorded on a time chart, and also such related information as time out for circulating, for repairs, round trips, etc. This makes it easy for the geologist to connect samples of cuttings with the time when the drill passed through the section. By making observations foot by foot as drilling proceeds, even thin strata of varying porosity can be recognized and located as to their depth. To-date six of these machines have been constructed and put to use in the Mid-Continent area, where they have accomplished their main purpose, which is to overcome the existing problem of lag in rotary samples that has made it difficult to detect and locate porous formations that should be examined for paying quantities of oil or gas.

Accuracy of the geolograph in indicating points of stratigraphic change has been checked by coring and electrical logging; the waves in the drilling-time record have been observed to conform closely to the waves of Schlumberger records. It is one more aid to accurate and scientific drilling for oil, provided due attention is given to its proper use.

## OPERATING

**The Bureau of Mines-A. P. I. Core Barrel (Progress report)**—D. B. Taliaferro and R. E. Heithecker, in Bureau of Mines Report of Investigations, No. 3481 (1939), 20 pages.

It is noted that recovery of core specimens from subsurface formations and their subsequent analysis are important aids in efficient development and operation of oil and gas fields.

Cores recovered from the producing formations may be analyzed for porosity, permeability, oil content, "connate" water content, and other physical and chemical properties of the formation, all to the end of furnishing enough data for making reliable estimates of the quantity and availability of oil and gas within a reservoir and in devising efficient means for their withdrawal.

The study of methods of determining the oil content of reservoirs under high pressures has resolved itself into three parts: (1) Development of a device to cut and seal core specimens under reservoir conditions: (2) development of a method to prevent the contamination of the core during the coring operation; and (3) development of a method of analyzing the cores recovered. Considerable work has been done on the first step; and a core barrel has been devised which appears to have good possibilities. Only preliminary study has been given to the second step, which seems to be the most difficult part of the program. Work on the third step has been begun, and a method of analysis has been outlined which from the initial test appears to offer a satisfactory solution to this problem.

**Properties of a Petroleum-Reservoir and Its Residua, with Applications to the Data of Production Problems**—Kenneth Eilert, R. Vincent Smith, and Alton B. Cook, in BUREAU OF MINES, REPORT OF INVESTIGATIONS, No. 3474 (1939), 47 pages, with numerous tables and graphs.

This work was undertaken for the following reasons:

Efficient and economic production of petroleum requires knowledge of the properties of reservoir fluids and their characteristics of flow through porous formations. The change in properties and flow characteristics of fluids when their composition is altered as a result of reservoir-pressure decline is of special importance in planning well-spacing programs and production schedules. Retention of the greatest possible quantity of dissolved gas in the reservoir liquid generally is recognized as essential to maximum ultimate recovery of oil from the underground reservoir. However, production methods tending to maintain gas in solution in the oil and resulting in the optimum economic recovery of oil not only vary from field to field but also may have to be changed from time to time in a given field as it is being depleted of its recoverable oil. Consequently there is need to investigate the properties of reservoir fluids corresponding to successive stages of reservoir depletion with the view of obtaining information essential to efficient production practices.

The end-result was the development of some methods for determining the properties of a reservoir fluid that are of particular significance to production practice, for which the original paper should be consulted.

Of particular interest to the petroleum technician is the analytical method described for comparing the compositions and other properties of hydrocarbon liquids obtained at different points in the flow stream. The amount of gas liberated from liquid solution and the resultant volume change in the solvent can be determined without knowledge of the pressure and temperature gradients and the type of liberation in the flow stream between the points at which the samples were taken.

## RESERVES

**United States Reserves Rising to New Peak**—W. L. Baker, in OIL WEEKLY, Vol. 96 (1939), No. 8.

During 1939 the proven petroleum reserves of the United States rose to a previously unreached height, that is, to 18,751,050,000 bbl., as compared with 17,348,146,000 bbl. at the close of the previous year; the net gain is 1,402,904,000 bbl. Total production during the year was 1,265,-261,000 bbl. which indicates that 2,668,165,000 bbl. were added to the underground reserves through the discovery of new fields, new producing horizons or extensions of old fields.

The significance of these figures may be appreciated by reflecting that the reserves now in sight are equivalent to 83 percent of all the oil produced in the United States since Drake drilled his first well 80 years ago.

The fact that our oil reserves continue to mount is clearly due to a constantly increasing rate of discovery. Of the 41,204,550,000 bbl. discovered since the start of the industry 30 per cent has been found in the last five years, during which time a total of 12,429,050,000 bbl. were discovered. This was 6,573,991,000 bbl. more oil than was produced during the same period, which is the more remarkable because the preceding five-year period witnessed the opening of the gigantic East Texas field, which to date is the largest single discovery ever made.

It may or may not be significant to note that the last five years were not quite as efficient in discoveries per well; completions in this period averaged potentials of 89,728 bbl. per well, as compared with 114,007 bbl. per well in the 1930-34 period. Texas, Illinois and Louisiana are now the three states with the largest reserves.

Although it stands to reason that as more oil fields are discovered fewer will remain for future discovery, it is evident that the United States is still many years removed from a shortage of petroleum resources.

## PIPELINES

**Internal Corrosion of Gasoline Pipe Lines**—L. C. Morris and W. A. Schulze, before AMERICAN PETROLEUM INSTITUTE, Chicago, November, 1939.

Experimental investigation of the causes of internal corrosion of gasoline pipe lines has shown air and aqueous treating solutions dissolved in or mechanically entrained with the gasoline to be the principal factors in tubercle growth and

pitting of the pipe. A turbidimeter has been used for measuring the amount of aqueous solution or solids in the gasoline stream.

Static, splashing, and circulating methods have been developed for studying the corrosion of pipe-line steel under a great variety of conditions.

As an inhibitor for this type of corrosion, mercaptobenzothiazole has given good results in laboratory, pilot-plant, and commercial-scale tests, with concentrations of the order of 1 lb. to 2 lb. per 1,000 bbl. of gasoline. Large-scale installations are located on the Phillips pipe line at Borger, Tex., and Laverne, Okla.

Test specimens which periodically are withdrawn from the Phillips line for inspection indicate that corrosion has been reduced markedly.

## CHEMISTRY

**The Accelerated Oxidation Test for Oils**—W. Francis, in JOURNAL INSTITUTE PETROLEUM, Vol. 25 (1939), No. 190, pp. 561-565.

Existing standard methods for the chemical examination of lubricating oils, particularly in their application to the measurement of the changes occurring in such oils under operating conditions, are regarded as unsatisfactory.

In (British) practice the oxidizability of oils is usually measured by the Michie test, which is to pass air at a standard rate through a standard volume of oil in which is placed a strip of clean copper foil; the whole is maintained at a standard temperature and the sludge formed and the change in viscosity or carbon residue are measured, and assumed to give an indication of the tendency to sludge. The difficulty with such tests is the time required, and relatively large errors.

Previous success with a method of determining the oxidizability of coals by means of their reactivity toward an alkaline permanganate solution suggested an application of this method to the oxidizabilities of oils. After preliminary research the following procedure was developed:

Samples of a turbine oil after varying periods of use were weighed into standard-sized flat-bottomed liter flasks and treated first with 40 ml. of normal caustic soda followed by 100 ml. of normal potassium permanganate. Each flask was then placed on a boiling water bath, where the temperature of the solution was approximately constant at 95° C. the contents were filtered, warmed to 60° C., acidified with sulphuric acid and rapidly titrated with normal oxalic acid. A parallel blank test with permanganate and caustic soda was made. The number of milliliters of normal permanganate solution required under these conditions is called the "permanganate number" of the oil, and is used as an index of oxidizability. More or less of the permanganate solution is taken, depending on the reactivity of the oil.

As would be expected, the permanganate number decreases with increased refinings; with highly refined mineral oils it is about 2. Experiment showed that the permanganate attacks the products of deterioration of the used oil rather than the oil itself; if the used oil is first extracted with alcohol and then tested it shows little reactivity, whereas the recovered extract reacts vigorously. It is noted that with a turbine oil, after several periodic centrifugalings to clean out sludge, the permanganate number may decrease. In another experiment the permanganate number of a new oil treated with an oxidation-inhibitor had a permanganate number of 4.4. After three years service the permanganate number was only 4.1, due presumably to a slight loss of inhibitor, a conclusion that was confirmed by a Grignard test. The new method is recommended not only for determining the oxidizability of new oils, but also the extent to which an oil has deteriorated in service.

**A Study of Some Phases of Chemical Control in Clay Suspensions**—Allen D. Garrison and K. C. ten Brink, in PETROLEUM TECHNOLOGY, Vol. 2 (1939), No. 4, Technical Publication No. 1124, 20 pages.

Before beginning work on this problem the authors devised a mud viscisimeter that fulfills three essential conditions: a wide variety of speeds, constant and continuous motion for a prolonged period of time, and smooth flowing of the sample at as nearly the same rate as possible. They have given a description, with drawings of the instrument. They then investigated the effect of deflocculating agents, the influence of pH and metallic ions, the effect of various sodium salts and the chemical reduction of hydration.

In the end, they conclude that in the practical chemical control of drilling clays it is necessary to recognize and distinguish the different forms and conditions of clay particles, and to adjust the factors that favor the desired forms. Thus, in the drilling of formations that have no or little mud forming ability, the highly dispersed forms should be favored; on the other hand, in drilling the more bentonitic clays highly dispersed and highly hydrated colloidal forms should be prevented from increasing to harmful amounts, especially when it has become necessary to add weighting material to the drilling fluid.

**Thermal Alkylation and Neohexane**—G. G. Oberfell and F. E. Frey, in REPORT 317-39 OF RESEARCH DEPARTMENT of Phillips Petroleum Company, Nov. 19, 1939; illustrated, 21 pages.

The thermal alkylation reaction is brought about by subjecting a mixture of paraffins and olefins to a temperature bordering on the cracking range, approximately 950° F., at a high pressure, for example 3000-5000 pounds per square inch, the high pressure being required to reverse the cracking tendency. Olefins are readily polymarized by themselves under such conditions, but by maintaining the concentration of olefin low and paraffin high during the reaction, the polymarization is held back and the union of paraffin with olefin becomes the predominating reaction. This entails the addition of olefin during reaction at such a rate that its concentration never becomes too high.

By the selection of individual paraffins and olefins for thermal alkylation primary reaction products result from the union of one molecule of each, accompanied by secondary products. Ethylene and propane yield mainly isopentane, some n-pentane; ethylene and n-butane, 3-methyl pentane; ethylene and isobutane, neohexane; propylene and propane, 2, 3-dimethylbutane and 2-methylpentane. Cycloparaffins react similarly, cyclohexane plus ethylene yielding ethylcyclohexane.

The most interesting of these products is neohexane, which is found to be a new aviation fuel ingredient, produced by the reaction of ethylene with isobutane under the conditions of thermal alkylation. The process consists of a cracking step wherein an ethane-propane mixture is cracked at 1425° F. to ethylene at low pressure followed by an alkylation step in which the ethylene is reacted with isobutane under high pressure.

In addition to neohexane, other motor fuel hydrocarbons are produced, mainly through secondary reactions, and lying almost entirely above the neohexane in boiling range. Owing to the low maintained concentration of ethylene in the reaction zone, the formation of tar, usual in thermal polymerization, is retarded and the total alkylate is yellow in color, containing little material above the motor fuel range.

Neohexane is one of the five possible isomeric forms of hexane. It is the most volatile of the hexane hydrocarbons. This volatility, and its extraordinarily high octane number of 100 (A. S. T. M.), and also its exceptionally high tetraethyl lead susceptibility make neohexane comparable with chemically pure isooctane. It therefore has a high blending value, as it combines high octane rating with the volatility which isooctane lacks.

Arrangements have been completed for large scale production of neohexane.

**The Catalytic Dehydrogenation Process (Gaseous Paraffins to Olefins)**—A. V. Grosse, V. N. Ipatieff, Gustav Egloff and J. C. Morrell, before AMERICAN PETROLEUM INSTITUTE, Chicago, November, 1939.

A process of catalytic dehydrogenation is described which is said to add enormously to the potential supply of high grade gasoline. The process applies to the conversion of gaseous paraffins, except methane, into the corresponding olefin and hydrogen. The paraffin used may be derived from natural gas, casing head gas, refinery gases, and gases from other sources, such as coal. Chief interest centers in the production of iso- and n-butanes for conversion into iso-octane, which is a prime base for high octane number gasoline.

A present means for obtaining olefins is the thermal cracking of paraffin gases. However, the new catalytic dehydrogenation process gives a much greater yield, both once-through and ultimate, as well as a much faster production rate of olefins than thermal cracking. In the thermal cracking reaction, substantial carbon-to-carbon bond splitting takes place; e.g., in the case of n-butane the yield of n-butenes does not exceed under best conditions, 15 percent of the charge.

Catalytic dehydrogenation of n- and iso-butane and of propane to the corresponding olefins is a highly-selective reaction and produces, on a commercial scale, 85 to 95 percent of the theoretical yield of olefins from paraffins. Actually, in the laboratory on a recycle basis, more than 95 percent of the theoretical yield of olefins from paraffins has been obtained. The catalytic reaction suppresses the occurrence of side reactions, such as the formation of methane and ethane from propane and butanes. Also, when processing butanes, it suppresses propene formation, and produces principally butenes.

The catalyst employed is of the chromium-oxide type on alumina. It is not poisoned by sulphur compounds nor by carbon monoxide. The activity and selectivity of the catalyst are practically constant, as is shown by a working period of approximately 2,000 hours. At least two catalyst cases are employed, one in production while the other is being regenerated by burning off the carbon which has deposited on the catalyst. The operating period is about one hour.

For the production of aviation gasoline the mixture of butane, butene and hydrogen coming

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from the dehydrogenation system is cooled, and scrubbed to remove hydrogen. The butane-butene product is compressed and polymerized by passage over solid UOP phosphoric-acid catalyst. The temperature of this operation is determined by the octane number desired. The polymerized product is debutanized and hydrogenerated to make aviation gasoline of approximately 97 octane number. Three such plants, to produce a total of 3,000 bbl. of butanes per day, are being installed.

## PHYSICS

**Flow of Gas-Liquid Mixtures Through Consolidated Sand**—Holbrook G. Botset, in PETROLEUM TECHNOLOGY, Vol. 2 (1939), No. 4, Technical Publication, No. 1111, 13 pages.

Unconsolidated sands are those whose grains have not been cemented together by lime or silica; they are loose or friable. Consolidated sands are those that have been turned more or less into firm, if porous sandstone.

As regards unconsolidated sand, it is known that there is a definite relationship between its liquid saturation and its permeability to the liquid or gas phase, and that the viscosity of the liquid has only a slight effect on the permeability-saturation relation.

However, since the sands that constitute petroleum reservoirs are more or less consolidated, it is desirable to know how they behave to gas-liquid mixtures. For this purpose the author selected a firm sandstone which had a permeability of about 0.8 darcy. The results show that the approach to equilibrium saturation is very little affected by the consolidation of the sand, and is probably dependent on the cementation and grain-size distribution. One result of apparent significance is that the ultimate recovery from a consolidated sand may be smaller than that of an unconsolidated one of the same permeability. In general, it appears that the method of testing and analysis used for examining unconsolidated ones, and, with the above mentioned limitation, may warrant the same general conclusions.

**Flow Characteristics of Lime-Base Greases**—J. F. I. Blatt and D. L. Samuel, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 232 (1940), No. 1, pp. 68-72.

The physical nature of petroleum greases constitutes a problem to which no agreed solution hasyet been found. Greases are described vaguely as colloidal dispersions of soaps in oils, or as water in oil emulsions stabilized by soap.

When grease is applied to a bearing, it is subjected to a shearing stress which will depend on the speed of rotation and the clearances involved. Under these conditions it will flow and its viscosity will become an important factor in the satisfactory running of the moving parts.

No measurements of the absolute viscosity of greases have been made, as appears from a survey of the literature. The author found that these measurements could be made with the help of Mooney's equation. The absolute viscosities at 25° C. of a number of lime-base greases have been determined in a capillary viscometer over a certain range of shearing stresses, and some approximate yield values have been measured in a concentric-cylinder torsion viscometer. Some empirical measurements have been made on the flow of the greases under comparatively high shearing stresses.

Mathematical expressions of the flow curves in the capillary viscometer have been found. These agree satisfactorily with the experimental results except in the neighborhood of the yield values.

The evidence of these experiments suggests that the viscosity of the oil base is the main factor determining the viscosity of the grease at shearing stresses well removed from the yield value and that the soap content probably controls the magnitude of the yield value.

**A New Laboratory Method for Rating Aviation Fuels of High Octane Number**—R. Stansfield and H. B. Taylor, in JOURNAL INSTITUTE PETROLEUM, Vol. 25 (1939), No. 190, pp. 566-572.

The development work leading to the method here suggested is based on two premises; first, any fuel must exceed a minimum value for its class when used under lean-mixture cruising conditions, and exceed a second minimum when used under rich-mixture conditions at take off, the two minima not necessarily being the same in terms of the reference fuels adopted.

Actual development of the method proceeded under the assumption that the motor method, itself a weak-mixture test which will agree with aero-engine weak-mixture ratings, should be capable of alteration to suit rich-mixture conditions. In adapting the motor method to this condition it was found necessary to discard such instrumental devices as the bouncing pin, the temperature plug, or oscillograph pressure diagrams. The decision was reached to use a cathode-ray oscillograph and an indicating unit showing the rate of pressure diagrams, and to take as the measure of knock the height of the first wave of the detonation and the maximum observed height in a minute.

The work showed that although the motor-method octane numbers of paraffinic, naphthenic and aromatic type fuels varied only between about 87 and 91, the spread under the 45 percent rich conditions was about 15 octane numbers as determined by tests on appropriate blends of C and F secondary reference fuels; other reference fuels gave entirely different ratios, while rating all fuels in relatively the same order. If this method of testing were adopted the specification for knock-testing an aviation fuel would require it to match a given blend of reference fuels for weak-mixing conditions, and a second blend for rich conditions.

## REFINING

**The Catalytic Cracking of Aliphatic Hydrocarbons**—Gustav Egloff, J. C. Morrell, Charles L. Thomas and Herman S. Bloch, in JOURNAL AMERICAN CHEMICAL SOCIETY, Vol. 61 (1939), pp. 3571-3580.

The thermal decomposition of long-chain aliphatic hydrocarbons is characterized by non-selective chain scission which is undesirable from a utilitarian viewpoint; but little systematic work has been done to develop catalysts which would induce a selective chain splitting. A review of the field led to the conclusion that difficulty reducible refractory oxides were the best potential catalysts for carbon-carbon bond scission.

A number of hydrocarbons cracked at atmospheric pressure in the presence of an activated silica-alumina catalyst showed the following behavior:

A mixture of *n*-butenes underwent extensive catalytic isomerization to isobutene in the temperature range 385 to 600 deg., accompanied by polymerization and cracking. Between 450 and 600 deg., the isobutene content of the $C_4$ product was 24.1 ± 1.5 percent.

*n*-Pentenes showed reactions similar to those of the butenes, yielding 50 percent of iso-pentenes at 400 deg.

A mixture of *n*-octanes underwent both catalytic isomerization to isooctenes and catalytic cracking to gaseous products consisting principally of equal amounts of normal and iso-butene. The results are consistent with the theory that isomerization precedes cracking. In the temperature range 375 to 400 deg., the conversion was over 80 percent.

The primary catalytic reaction of cetene in the range 300 to 450 deg. was isomerization to iso-hexadecenes; the secondary reaction was cracking to lower-boiling olefins, accompanied by isomerization of normal olefinic products to iso-olefins. The isohexadecenes catalytically cracked approximately three times as rapidly as cetene itself.

*n*-Octane catalytically cracked seven to eight times as rapidly as in thermal decomposition, and the catalytic products contained more $C_3$–$C_7$ hydrocarbons and less methane, ethane, and ethylene than the pyrolytic products. The temperature required for the catalytic cracking of octane was 200 deg. higher than that required for n-octenes.

Cetane was catalytically cracked largely to $C_3$, $C_4$ and $C_5$ hydrocarbons. The gasoline boiling-range products contained both branched-chain and straight-chain hydrocarbons, in contrast to the products of cetene cracking, which were essentially all branched-chain.

Although the behavior in thermal cracking of cetane and cetene is quite similar, cetane is far more stable toward catalytic cracking than cetene In both cases, the products of catalytic cracking are quite different from those of pyrolytic cracking.

## USES

**Investigations on Diesel Fuels by Various Testing Methods**—O. Widmaier in OEL UND KOHLE, Vol. 35 (1939), No. 41, pp. 761-763.

It is generally agreed that there is a pressing need for a simple method of testing Diesel fuel oils. A number of testing methods have been proposed, but the question still remains: which one (if any) gives reliable results?

This question can be answered only by testing large numbers of samples by different methods and comparing the results among themselves and with practical experience in the use of the fuels. As a contribution to this work the author tested 14 Diesel fuels by three methods, namely:

The Marder density method;
The HWA (German Ordnance Department) engine method;
The FKFS(Stuttgart Fuel and Power Research Institute) engine method.

The Marder method is a laboratory procedure in which the ignition quality of a Diesel fuel is calculated from the density and the "boiling number" of the oil. The HWA engine method is based on control of the degree of compression in the engine; the FKFS engine method measures the ignition delay. In all cases the ignition quality is expressed as the cetene number of the oil.

The Marder density and boiling number

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method generally gives lower values than the HWA method, but agrees better with the FKFS method. When the two engine methods are compared the HWA method uniformly gives higher values than the FKFS method. However, the two engine methods show closer agreement if their results are expressed as cetane numbers instead of cetene numbers. This agreement of the cetane numbers is especially good in the case of Diesel fuels of medium ignition quality. The HWA method rates poor oils lower and the best oils higher than the FKFS method. In general, the FKFS method, which gives reproducible values within plus or minus 1.5 cetane number, would seem the most dependable, especially as it agrees closest with the Marder method.

**Extreme Pressure Lubricant Tests with Pretreated Test Pieces**—J. P. Baxter, C. I. Snow and I. T. Pierce, in JOURNAL INSTITUTE PETROLEUM, Vol. 25 (1939), No. 194, pp. 761-770.

In the course of work on the production and testing of extreme pressure lubricants, experiments were carried out on three well known lubricant-testing machines (Timken, Four-Ball and Cornell or Falex) to investigate the formation of the film on the bearing surfaces, which is believed to underlie the phenomena of E. P. lubrication. The experiments were made with undoped and with doped oils. A doped oil is a mineral oil which has received an addition of material containing chlorine, sulphur or other substances.

It was noticed that the load-carrying ability of used test pieces was greater than that of new or fresh pieces. This raised the suspicion that the dope in the oil had altered the surface of the bearing. Experiment showed that by heating the test piece in the dope for 5 minutes at 200 deg. C. a uniform coating appeared on them, with the result that the breakdown load was increased, even when the test was repeated with undoped oils. A natural suggestion is that metal parts intended for extreme-pressure lubrication should be heated in a doped oil before being put to use.

It was further noticed that one of the most active products of the high-temperature decomposition of chlorinated dopes is hydrochloric acid, and some tests were therefore carried out by treating test pieces with this acid. The acid treatment consists in placing the pieces in 10-normal hydrochloric acid for 5 minutes at 50 deg. C., followed by washing them in water. The same increase of breakdown load was obtained as with chlorine and sulphurized dopes. However, pretreatment of the Cornell (or Falex) test-pieces had no apparent effect, but when these were hardened to a value comparable to that of the other machines the breakdown loads became too high for the machine to measure.

## ECONOMICS

**Alkylation and Its Influence on Utilization of Natural Gasoline**—Earle W. Gard, A. L. Blount and K. Korpi, before CALIFORNIA NATURAL GAS ASSOCIATION, November, 1939.

This paper outlines the chemistry of alkylation by various methods, mainly the sulfuric acid process of uniting olefins and iso-paraffins, and ends by considering the economics of the subject, with special reference to California.

It is estimated that 2,100,000 barrels of alkylation product could be obtained from the olefins produced in California each year. The aviation gasoline fraction would amount to about 1,800,000 barrels annually, and it would have a clear knock rating of about 91 iso-octane (ASTM method). This fraction would be rated 100 iso-octane by the ASTM and Army methods when it contains not more than 1.5 ml. of tetraethyl lead per gallon. By blending with suitable straight-run fractions as aviation gasoline with a knock rating of 100 iso-octane and containing a maximum of 3 ml. of lead per gallon could be produced in an amount equal to about 2,900,000 barrels per year.

It is estimated that the present yearly local demand for aviation gasoline with a knock rating in excess of 86 (ASTM) equals about 400,000 barrels. Therefore, it appears that the potential annual production of aviation gasoline by the alkylation process is from four to seven times the present annual demand for such fuel.

It is the opinion of the authors that it is not economical at present to use alkylation as a process for the manufacture of a blending stock for use in regular motor fuels. Aviation gasoline with a knock rating of 100 iso-octane is selling at present for 15 to 16 cents a gallon. The margin between the selling price and the cost of the material is relatively small considering the size of the investment for plant equipment. It is estimated that alkylation plant costs about $2,500 per barrel of product per day which is about eight times the cost of a cracking plant on the same basis.

It is obvious that companies with refinery facilities can use some of the existing equipment in connection with the alkylation plant and thus reduce the initial expenditure. The extent of the reduction, however, is dependent on the availability of such existing facilities for the new use.

## BOOKS

**Tanker Freight Rates and Tankship Building**—By T. Koopmans, published 1939 by NETHERLANDS ECONOMIC INSTITUTE, London, Eng. and Haarlem, Holland; paper, 219 pages; 2 florins.

The tanker industry is the carrier of all overseas oil trade. Although a tanker is a ship, tanker freight rates rest on a wholly different basis and have no relation to other maritime rates. Besides this the tanker business has many complicated angles peculiar to itself. Tanker rates and tanker construction are subject to wide swings and cycles.

In this study the author holds a clinic on the tanker business and searches for the causes of the fluctuations it has undergone, and he especially inquires into the Tanker Pool to see how and why it succeeded in establishing more remunerative rates and in mitigating the fluctuations of the tanker market; from this he analyzes the conditions on which a continuance of its operations is subject. The book is one to be read with profit by everyone who is seriously interested in shipping oil in tankships.

**Evaluation of Petroleum Products, A Resume of Present Information,** Sponsored by Committee, A.S.T.M., and published 1940 by AMERICAN SOCIETY FOR TESTING MATERIALS. Philadelphia; 52 pages, 75 cents.

This is a collection of six papers, each by a specialist, in which the present status of the testing of petroleum products and lubricants is summarized. They are entitled: "Lubricating Oils", "Petroleum Lubricating Greases", "Gasoline", "Diesel Fuels", "Fuel Oils Other than Diesel", and "The Status of Research on Fuels and Lubricating Oils for Spark-Ignition Aircraft Engines."

In each paper the writer lists the standard A.S.T.M. methods and closes with a comprehensive bibliography containing references to original sources. In between, he gives a summary of the characters which the methods have been designed to reveal. In other words, the reader's attention is directed to the reasons why the tests are made and how the results may be interpreted rather than to details of the methods themselves. The need of more and better methods is pointed out. From that standpoint the six papers has something of interest to users of petroleum products as well as to petroleum chemists.

**A. S. T. M. Specifications for Pipe and Piping Materials for High-Temperature and High-Pressure Services**—Published December 20, 1939 by AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; 143 pages; $1.25.

This compilation provides a selected group of A. S. T. M. specifications of interest in the field of power and piping installations. The book has been in widespread service, especially in the utilities field in connection with high temperature and high pressure work. Twelve of the twenty-three specifications cover various types of carbon and alloy steel pipe and boiler tubes, etc., including the specifications for classification and dimensions of wrought iron and wrought steel pipe. Carbon and alloy steel castings for valves, flanges and fittings are covered in four of the specifications and forged or rolled alloy steel pipe flanges in three other standards. Three of the specifications pertain to alloy steel bolting materials and carbon and alloy steel nuts. An important addition is the standard on classification of austenite grain size in steel with two grain size charts.

**A. S. T. M. Standards on Petroleum Products and Lubricants, prepared by Committee D-2,** published by AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; 336 pages, $2.00.

Sixty-two standardized methods of test, ten specifications and two lists of definitions and terms comprise the latest (September, 1939) edition of the compilation of the A. S. T. M. Standards on Petroleum Products and Lubricants. This edition includes several new standards published for the first time covering carbon residue (Ramsbottom method), gum stability of gasoline, determination of tetraethyl lead in gasoline, consolidated specifications covering A. S. T. M. thermometers, and others. Each of the 74 items is given in its latest approved form, a number of changes having been incorporated during the current year.

The annual report of Committee D-2 includes discussions on gum and tetraethyl lead. A test for neutralization number of used aviation oils and proposed specifications for aviation gasoline published for information are also included.

**Practices and Methods of Preventing and Treating Crude-Oil Emulsions,**—By G. B. Shea, published as BULLETIN NO. 417, 106 pages, 30 cents.

Oil-water emulsions continue to present a major operating problem in the oilfields. If every such emulsion were just like any other the matter would be greatly simplified, but as each emulsion and the conditions under which it is produced

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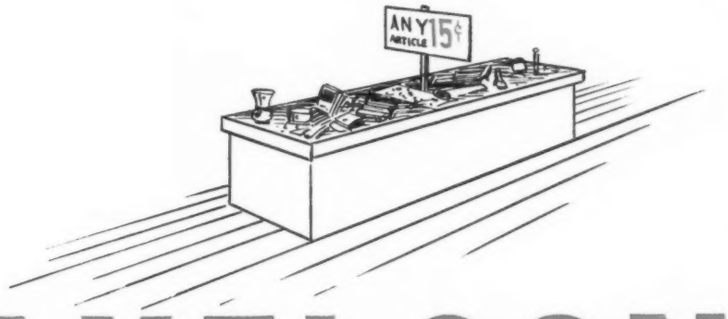

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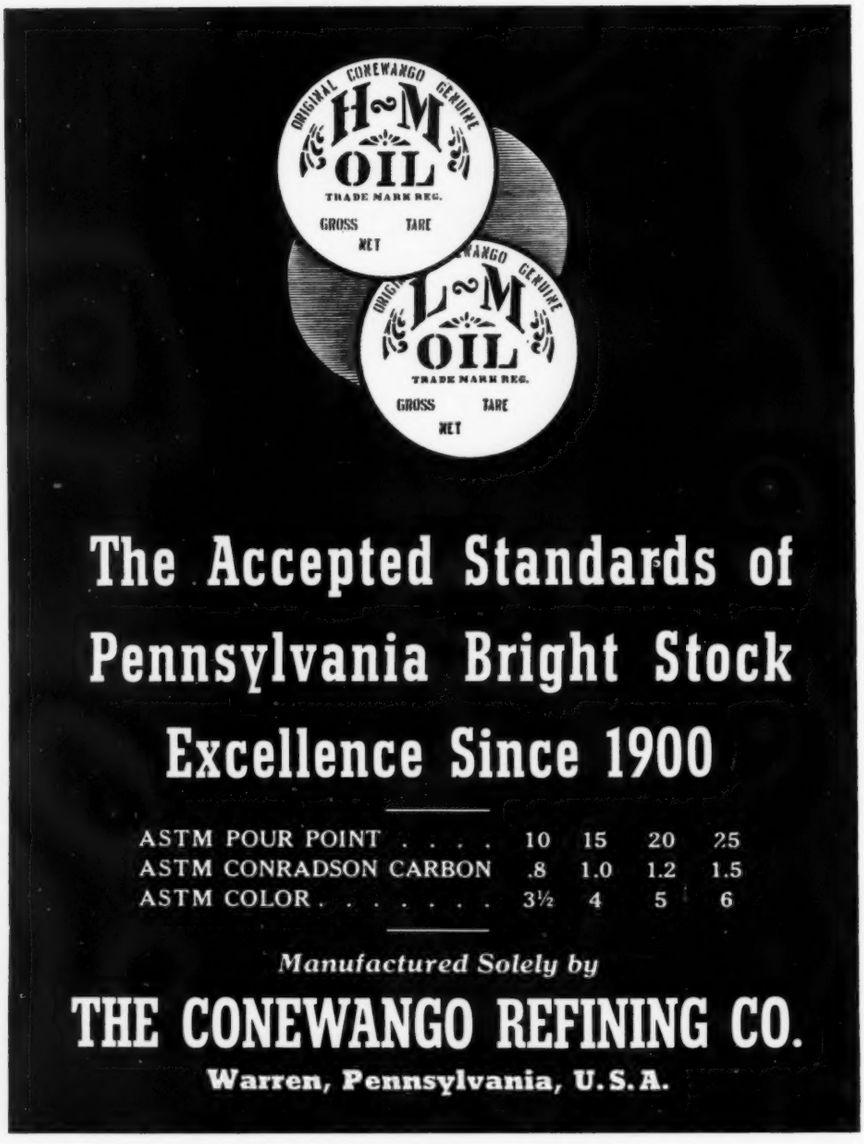


present an individual case its particular remedy has to be sought out.

This treatise, which is a revision of a similar work published in 1926, will be of distinct service to the petroleum engineers concerned with this phenomenon. The principal causes of emulsioning are enumerated and the various known treating methods are enumerated. With this general knowledge before him the engineer should have little trouble in finding how to approach the problem by the shortest path to a solution.

**$200,000 Industrial Award Program,** published 1940 by JAMES F. LINCOLN ARC WELDING FOUNDATION, 48 pages.

This booklet outlines the fields of welding research and experimentation in which persons connected with manufacturing firms employing welding processes may win prizes for meritorious contributions to the science and practice of welding.

**Technology, Employment, and Output per Man in Petroleum and Natural-Gas Production**—By O. E. Kiesaling and fifteen others; published 1939 by WORKS PROGRESS ADMINISTRATION, NATIONAL RESEARCH PROJECT AND DEPARTMENT OF INTERIOR BUREAU OF MINES; paper, 349 pages; obtainable from Publication Section, Division of Information, W. P. A., Washington, D. C.

This volume is part of a large series of research reports on employment, unemployment and relief. Reports previously issued have covered various branches of manufacturing, mining, agriculture and selected industries, all with the object of finding out what the employment problem really is and is likely to become.

In this report the authors make a thorough and illuminating analysis of the state of each major section of the petroleum industry; exploration, discovery, drilling, production of oil, natural-gas and natural-gasoline, transportation, storage and refining, with especial reference to the industry as a work-giver. Since the object of the research was not only to obtain a picture of the present state of employment and unemployment of petroleum workers, but also to forecast what the employment problem will be in the years to come, they have reviewed past conditions in order to make a guess at future trends. In thus reviewing the evolution of the different departments of the industry the authors have actually produced a very readable and interesting account of the development of petroleum technology from the beginning. Quite apart from the main theme of the book, which is labor from the social-economic angle, this survey can be recommended as well worth reading by those who wish to refurbish their knowledge of the broad lines of the history of petroleum technology; it is not too technical even for the general reader.

As regards the main point of the report, which bears on how employment in the petroleum industry has fared and is likely to fare in the coming years, the authors note that in general employment has increased with expansion of the industry, and has decreased in certain departments as a result of technological progress. This last has been especially marked in the refining industry, where in the past decade the productivity of labor (man-hours per unit of product) has increased ninefold, Nevertheless, and on the whole, both the short and the long-time outlooks indicate that additional workers will be required in the petroleum and natural-gas industry. This increase will follow because of the expected growth of demand for motor fuel and lubricants

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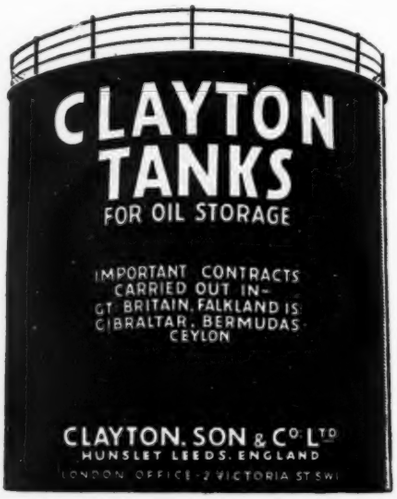


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and by the coming shortening of the standard work week, which will necessitate more hands. This covers the next decade and a half. Beyond that the prospect is clouded by uncertainty as to whether visible petroleum reserves are still on hand for the industry to work on. However, by that time we will begin to depend on petroleum from oil shales and synthetic petroleum from coal, both of which will create a large demand for labor. In any case the demand for unskilled labor is now rapidly disappearing in most branches of the industry, such as exploration, refining and transportation. The trend is now toward technicians and skilled and semi-skilled workers and away from floating crews of roustabouts. In drilling there is still heavy work for the laborer, but even here increasing proportions of skilled men are required.

To conclude, it is a worth while book.

**La Industria del Petroleo en Colombia (The Petroleum Industry in Colombia)** by Felix Mendoza and Benjamin Alvarado; published 1939 by MINISTERIO DE LA ECONOMIA NACIONAL, Dept. de Petroleos, Bogota, 217 pages, double column. Text in Spanish and English.

This bilingual publication, compiled by two professors holding positions in universities in the United States, is intended to enlighten foreigners on the land of Colombia and especially on its petroleum industry. A general account is given of the physical character and the political regime of the country. The history of petroleum in Colombia is traced, followed by an account of the present development of the industry by the companies which have held concessions. The Tropical Oil Company, as the greatest of these enterprises and the one which now produces practically the entire output, comes in for an extended notice. The national oil statistics of production, exportation and refining are contained in 14 tables.

There is a short chapter on the oil geology. Somewhat less than half the book is devoted to the legislation and decrees by which prospecting, production exportation and refining are regulated.

## GENERAL

**Was the Course and Result of the World War Influenced by Petroleum?**—F. Friedensburg, in PETROLEUM, Vol. 35 (1938), No. 28, pp. 495-502; No. 29, pp. 517-522.

The author, who has made exhaustive studies and has written a book on petroleum in the World War ("Das Erdoel im Weltkrieg"; Engke, Stuttgart) here gives a general summary of his conclusions. Reduced to the final analysis, up to near the end of the war the central powers were not so far short of oil for military use that they were much handicapped in comparison with the allied powers. It was fortunate for the Germans that when the Russians withdrew from Galicia in 1915 they neglected to make a complete job of destroying the Polish oilfields; on the other hand it was unfortunate for the Germans that the Austrians did not hold back the Russians long enough to give the Falkenhayn army time to seize the Roumanian oilfields, which the Allies were very careful to destroy. However, in 1918 the oil situation with the Germans became much worse, but to credit this circumstance alone with the German breakdown is an exaggeration: it is to be regarded rather as the last straw that broke the camel's back.

As regards inferences to be drawn for the future, it is clear that oil will be of far greater importance in the next great war than it was in the last one. The author calls on his fellow Germans to put forth every effort to assure their oil supply, either by developing home resources, the use of substitutes, by establishing political and economic relations with neighboring countries from which supplies may be obtained, and as a final resort the accumulation of a reserve supply. In time of war the rate of consumption will not be less than three or four times the peace-time requirement. When war does break out every effort must be made to protect home oilfields, refineries and depots from bombers and from raids by "parachuters."

Opportunities to seize oilfields in hostile territory must not be neglected, but not much is to be hoped for in that regard, as the enemy will doubtless take good care to make the oilfields useless to the invaders. Meanwhile, nothing is to be left undone to cripple the enemy's oil supply by air and submarine attacks, and by sabotage.

**Protection from Dangerous Gases in Oil Tanks**—A. W. Cox, in JOURNAL INSTITUTE PETROLEUM, Vol. 25 (1939), No. 189, pp. 416-425.

The prevention of fire and explosion in the petroleum industry has always been a serious problem, owing to the highly inflammable and explosive nature of many of its constituents. From the time oil is produced at the well until it is consumed by evaporation, inflammation or explosion the production, treatment, storage, transport and use of petroleum must be accompanied by suitable precautious against accidents. The subject is a wide one, with many aspects. The present paper is concerned chiefly with the safety of empty tanks that have been used for storage or transport, and must now be entered for inspection or cleaning. The one thing necessary in such circumstances is to assure that the tank has been previously cleared of all hydrocarbon vapors that form explosive mixtures with air or injuriously affect the workmen. Methods for freeing the tank from hydrocarbon vapors are more or less standardized in the industry. Exactly how successful these methods have been in removing danger will be shown by a proper instrument for detecting the presence of inflammable gases and for estimating the quantities present. One of the best of such inflammable gas detectors is the Redwood vapor detecting apparatus, which uses a hydrogen flame, and is both very sensitive and speedy in operation. Thorough sampling of the air in the tank is necesssry in order that no pockets of inflammable gas will be overlooked.

**Catalytic Dehydrogenation of Mono-olefins to Di-olefins**—Aristid V. Grosse, J. C. Morrell, and Julian M. Mavity, before AMERICAN CHEMICAL SOCIETY, Boston, 1939.

Mono-olefins have been dehydrogenated catalytically to give conjugated di-olefins of the same carbon framework. The most satisfactory catalysts consists of chromium, molybdenum, or vanadium oxide on alumina. Since the reaction is favored by low pressures and high temperatures the conditions usually used were 0.25 atmosphere or less and 600 to 650 deg. C. The di-olefins formed were butadiene-1, 3 from n-butylenes; isoprene from 3-methylbutene-1 and from a mixture of 2-methylbutene-1 and 2-methylbutene-2; and piperylene from pentene-2 The once-through yields varied from 20 to 30 percent; ultimate yields of butadiene-1, 3 up to 80 percent were obtained. Cyclopentadiene was obtained by dehydrogenating cyclopentane.